This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

3 3433 06272171 1

OCA
QUARTER

QUARTERLY JOURNAL

OF

MICROSCOPICAL SCIENCE:

EDITED BY

EDWIN LANKESTER, M.D., F.R.S., &c.,

AND

E. RAY LANKESTER, B.A. Oxon., F.R.M.S.

VOLUME IX.—NEW SERIES.

With Illustrations on Wood and Stone.

LONDON:

JOHN CHURCHILL AND SONS, NEW BURLINGTON STREET.

1869.

NEW YORK
PUBLIC
LIBRARY

PRINTED BY
J. E. ADLARD, BARTHOLOMEW CLOSE, E.C.

MEMOIRS.

New Observations *upon the* Minute Anatomy *of the* Papillæ *of the* Frog's Tongue.

By Lionel S. Beale, M.B., F.R.S., Fellow of the Royal College of Physicians, Professor of Physiology and of General and Morbid Anatomy in King's College, London; Physician to King's College Hospital, &c.[1] With Plates I—IV.

In this paper I propose to give the results of some recent investigations upon the minute anatomy of the beautiful fungiform papillæ of the tongue of the little green tree-frog (*Hyla arborea*). The specimens have been prepared according to the principles laid down in former communications. The success I have met with in this and other minute anatomical inquiries is, I believe, almost entirely due to the process of investigation which I have adopted for some years past, and which enables me to render specimens very transparent, and to demonstrate *all the tissues* in one specimen, a result which, as far as I am aware, can be obtained in no other way. By this plan sections are obtained so exceedingly thin, without the destruction even of the most delicate tissues, that they may be examined under the highest powers which it is possible to obtain ($\frac{1}{12}$ magnifying 1700 linear, and $\frac{1}{30}$ magnifying about 3000 linear).

The following are among the most recent contributions to the anatomy of the papillæ of the frog's tongue:

Waller: "Minute Structure of the Papillæ and Nerves of the Tongue of the Frog and Toad," 'Philosophical Transactions,' 1847.

Billroth: "Ueber die Epithelzellen der frosch-zunge, sowie über den Bau der cylinder-und flimmerepithelien und ihr Verhältniss zum bindegewebe," 'Archiv für Anat. Phys.,' 1858, S. 163.

Hoyer: "Mikroskopiche Untersuchungen über die zunge des Frosches," 'Archiv für Anat. Phys.,' 1859, S. 488.

[1] This paper has been reprinted from the 'Phil. Trans.,' but has been carefully revised by the author for this Journal. Several additions have been made to it, and a new figure added.

Axel Key: "Ueber d. Endigungen d. Geschmäcksnerven in der zunge Frosches," 'Müller's Archiv,' 1861, S. 329.

Hartmann: "Ueber die Endigungsweise der nerven in den Papillæ-fungiformes der Froschzunge," 'Archiv für Anat. Phys.,' 1863, S. 634.

Engelmann: "On the Terminations of the Gustatory Nerve in the Frog's Tongue," 'Siebold und Kölliker's Zeitschrift,' Bd. xviii, heft i.

In Part I of 'Max Schultze's Archiv' for 1868 will be found "A Memoir on the Taste Papillæ of the Tongue," by Dr. Christian Lovén, translated from the Swedish, to which attention may be directed. The author records the demonstration of some peculiar cells which are probably connected with the sense of taste in the higher vertebrata. The cells in question, which are interspersed amongst the ordinary epithelial cells, perhaps correspond with the mass of cells of the papillæ of the frog's tongue described in this paper, which are, without doubt, very intimately connected with the nerve-fibres of the plexus, which I have demonstrated, at the summit of the papilla.

Although the views of Axel Key are supported by schematic figures which do not accurately represent the real arrangement of the tissues, they approach much nearer to the truth than those of other observers. He describes two kinds of cells at the summit of the papilla, epithelial cells and special cells concerned in taste. I have not been able to verify his statements in this particular. He has not demonstrated the peculiar network at the summit of the papilla which is seen so distinctly in my specimens, and his delineations of the prolongation of the axis-cylinder alone, and its division into fibres far too fine to be visible by the magnifying powers employed, and the abrupt cessation of the white substance delineated by him, are evidently schematic,—indeed, he does not pretend that the figures referred to are copies from nature. Still his inferences regarding the division of the nerve-fibres into very fine fibres which pass into the epithelium-like tissue at the summit of the papilla, approach much nearer to the actual arrangement than those of any other observers with which I am acquainted.

Among the later researches upon the mode of termination of the nerves are those by Dr. Hartmann. These are concluded in the number of Reichert and Du Bois-Reymond's 'Archiv' for 1863. The drawings of the papillæ accompanying this memoir, especially fig. 65, Pl. 18, which I have copied (see fig. 24, Pl. IV, of this memoir), form an excellent illustration of the

fact that the most beautiful and well-defined structures may be rendered quite invisible by being soaked in aqueous solution of bichromate of potash for three days, one day in carmine solution, and then in caustic soda!

In order that I may not express myself against the mode of preparation followed by this and many other observers in Germany in the present day more strongly than is justified by the results obtained as shown by their own drawings, I would refer to Hartmann's figure. Of this drawing it is not too much to say that it represents nothing sufficiently definite to enable any one to form an idea of the structure of the part. The drawing, and I conclude the preparation from which it was taken, are far behind the day; and it seems to me most remarkable that after all the anatomical research of the last twenty years an observer should publish such a figure as this as a representation of natural structure. The nerve-fibres are completely altered by the mode of investigation followed, and the finer fibres are of course destroyed or rendered invisible. Nor can I admit that the epithelium upon the summit of the papillæ represented in his fig. 64 gives a correct idea of this structure.

Unfortunately, Engelmann, who is the last writer on the subject, does not appear to have seen my paper, which was published three years before his own memoir. He, however, confirms some of my observations, but has evidently failed to see the numerous nuclei connected with the subdivisions of the nerve-fibres, and represented in my figures 1, 2, and 3. That remarkable and intricate plexus of the very finest nerve-fibres which I have described and figured has also escaped his observation. But it would have been impossible for him to demonstrate these and many other points by the process of investigation which he followed, while the papillæ of the *Rana temporaria* are not at all well adapted for studying the finest ramifications of the nerve-fibres.

It may be proved conclusively by experiments that soaking delicate animal tissues in dilute aqueous solution of bichromate of potash renders invisible and destroys structures which can be demonstrated by other means. Inquiries conducted by the aid of such plans of preparation retard rather than advance anatomical inquiry, for some of the most important anatomical characters are rendered completely invisible. The very conflicting opinions now entertained by observers in Germany upon the structure of these papillæ, render it important that they should be studied again with the advantage of the highest powers and the most advantageous methods of preparation which we now possess.

In this communication I shall only attempt to describe briefly those points which I believe to be new, and which are, I conceive, demonstrated in my specimens for the first time. Most of the points described in this paper were demonstrated in 1862, and the specimens have been repeatedly studied and shown to other observers. The points described could still be demonstrated in the same specimens in June, 1864.

The structures entering into the formation of the papilla are the following:

1. The connective tissue which forms the body of the papilla.
2. The "epithelium."
3. The nerve-fibres in the body of the papilla, and the fibres prolonged from them which form a plexus upon its summit.
4. Nerve-fibres ramifying in the connective tissue, upon the capillary vessels and amongst the muscular fibres.
5. The muscular fibres.
6. The vessels.

The Connective Tissue.

The nerves, vessels, and muscular fibres are embedded in a very transparent basis-substance which exhibits a slightly striated or fibrous appearance when stretched, but this structure in all the papillæ of the Hyla is exceedingly delicate and transparent.

The great majority of the masses of germinal matter (nuclei) seen in this basis or connective substance are undoubtedly connected with the nerves, vessels, and muscular fibres, but there are a few which seem to belong to the connective substance alone, and may therefore be called "*connective-tissue corpuscles.*" It is possible that these at an earlier period may have been connected with nerves or muscles; at any rate, they are the descendants of the same nuclei or masses of germinal matter as the nuclei taking part in the production of these tissues.

I consider that indefinite connective tissue of this kind results principally from the accumulation of the remains of higher structures, especially nerve-fibres, which were in a state of functional activity at an earlier period of life. At an early period of development nuclei (masses of germinal matter) can alone be detected. As development proceeds, tissue is formed by these nuclei, and increases as age advances. The large and fully-formed fungiform papillæ have twice as many nerve-fibres as smaller and younger ones. During the development of such an organ as one of these papillæ many

changes occur, and much texture is probably produced and removed before the papilla attains its fully developed state. That passive substance called connective tissue which remains and occupies the intervals between the higher tissues, which possess active and special endowments, slowly accumulates, but undergoes condensation as the organ advances in age. Amongst this are a few nuclei which can no longer produce anything but indefinite "connective tissue" of the same character. In Pl. II, fig. 9, it would have been impossible, had the specimen been prepared in the usual manner, to have determined if the nuclei marked *a*, *b* were nuclei of the muscle concerned in producing muscle, or connective-tissue corpuscles concerned in the formation of connective tissue only. This question requires restudy from a new point of view. It is quite certain that many of the masses of germinal matter (nuclei) figured in all my drawings in connexion with *nerves, vessels, muscles,* and *other tissues,* would, if the specimens had been prepared in a different manner, so that their connexions were not so very distinctly seen, have been called "CONNECTIVE-TISSUE CORPUSCLES."

The drawings accompanying my paper explain the relation which I believe the essential structures entering into the formation of the papilla bear to the indefinite connective tissue in which they lie embedded.

Epithelium.

The so-called epithelium upon the summit of the papilla of the frog's tongue (Pl. I, fig. 1, *a*) differs from the epithelium attached to its sides (*b*), that covering the simple papillæ (*c*), and that on the surface of the tongue generally, in many important characters. As is well known, it is *not ciliated.* The cells differ from the ciliated cells in several points. They are smaller than these. The nucleus is very large in proportion to the entire cell. The cells are not easily separated from one another, as is the case with the ciliated epithelium. These cells form a compact mass, the upper surface of which is convex. This is adherent by its lower surface to the summit of the papilla, and it is not detached without employing force. The cells do not separate one by one, as occurs with the ordinary epithelium, but the whole collection is usually detached entire, and then it is, I believe, *torn away.*

Although some observers would assert that the two or three layers of cells represented in my drawings do not exist, but that the appearance is produced by the cells of a single layer being pushed over one another by pressure, I am convinced

that in this mass upon the summit of the papilla of the Hyla there is more than the single layer of cells represented by Hartmann, who is the latest observer on this point.

Hartmann's representation (*l. c.*) of this very same structure from the summit of the papilla of the Hyla is very different from my drawings. Not only do we represent these same cells of very different shapes, but the nucleus in my specimens is three or four times as large in proportion to the cell as represented by him.

The general outline of the free surface is convex (*a, a, a,* fig. 1, Pl. I), and the tissue which intervenes between the nuclei appears very transparent and projects a little, so as to give the convex summit a honeycombed appearance (Pl. II, fig. 7).

The under concave surface of this hemispheroidal mass which adheres to the summit of the papilla of the Hyla's tongue, corresponds to the exact area over which the nerve-fibres of the papilla are distributed, as will presently be shown. The shape of these cell-like bodies, of which the mass is composed, and their connexion with fibres, is shown in Pl. II, fig. 3, and in the very highly magnified specimen represented in fig. 2, Pl. I. These figures, I believe, represent the actual arrangement, but the point is most difficult of investigation. In the intervals between what would be called, if they were capable of complete separation from one another, the individual cells, fibres are seen. These fibres do not, I think, arise simply from the pressure to which the masses have been subjected. I have represented the arrangement as I believe it to be in Pl. II, fig. 6, from the central part of one of the hemispheroidal masses. I regard the entire hemispheroidal mass as resembling in its essential structure the network I have described at the summit of the papilla, but the masses of germinal matter are so very close together and the fibres so much interlaced with one another, that it is most difficult to unravel the mass without destroying it. The arrangement at the surface is seen in Pl. II, fig, 7.

The epithelium of the tongue generally is easily removed, but many of these hemispheroidal masses remain connected with the summits of the papillæ to which they belong. From what I have stated, it will, I think, be admitted that the constituent parts of the mass at the summit of the papilla could not be properly called epithelial cells, so that, with reference to the termination of the nerves in the papilla, I think it is more correct to say that nerves may be traced to special bodies or cells which form a hemispheroidal mass attached to the summit of the papilla, than to assert that the separate

bodies, which compose the mass in which nerves terminate, are actual epithelial cells.

In the simple papillæ (Pl. I, fig. 1, *d*) of the frog's tongue, a "nucleus" of a nerve sometimes projects beyond the outline of the papilla and lies amongst the epithelium. This nucleus, however, adheres to the papilla when all the epithelial cells have been detached. It might from its position be easily mistaken for an epithelial cell, but it is no more really related to this structure than is a ganglion-cell, or a caudate nerve-cell of the spinal cord. The cells of the ciliated epithelium of the frog's tongue are not in any instance, as far as I am able to observe, connected with the nerve-fibres. It is probable that the opposite inference, which is still held by many observers, has resulted from the observation of such a nucleus as is represented in Pl. I, fig. 1, *d*, projecting beyond and adherent to the surface of the papilla. It is really continuous with the delicate nerve-fibres (*e*) ramifying in the substance of the papilla, but it is not an epithelial cell, and remains adherent after every particle of epithelium has been removed.

More recently, the view that the finest ramifications of the nerve-fibres run amongst the epithelial cells of various tissues has been gaining ground, but it is probable this will turn out incorrect.

The nervous tissue is in all cases structurally distinct from every other tissue, in every part of its distribution. It never blends with epithelium any more than it blends with fibrous tissue, cartilage, bone, or muscle. If nerves exert any direct influence upon the nutrition of any of these tissues, the influence must be exerted through some distance. The results of anatomical research render any physiological doctrine which maintains that nerves act through their structural continuity with other tissues untenable. My own observations lead me to conclude that nerves do not directly influence the processes of nutrition, growth, or development at all. They act only indirectly, and affect the supply of nutrient matter distributed, by modifying the calibre of the vessels, and hence regulate the supply of blood which passes to the capillaries. The nerves, I believe, really exert their influence upon the contractile muscular coat of the small arteries and veins alone, and do not act directly upon any other tissues.

The Nerves.

With regard to the trunks of the nerves, I remark the following facts of importance:

1. That the bundle of nerve-fibres distributed to a papilla always divides into two bundles which pursue opposite directions. The division of the bundle may take place just at the base of the papilla, or at some distance from it, but it always occurs (Pl. I, fig. 1).

2. Fine pale nerve-fibres pass from the same trunk of dark-bordered fibres as that which gives off the bundle of nerves to the papilla. The fine fibres ramify—

a. Amongst the muscular fibres of the tongue (figs. 1, 9).

b. Upon the vessels (fig. 1, *i*, *i*, *i*).

c. In the connective tissue of the tongue generally, and also in the simple papillæ (fig. 1, *d*, *e*).

The division of the bundle at the base of a papilla is shown in Pl. I, fig. 1, and in Pl. III, fig. 10, is a diagram to indicate the manner in which the nerve-plexuses at the summits of the papillæ are connected together by commissural fibres. Thus, in action the papillæ may be associated together. The bearing of this arrangement upon the existence of complete nervous circuits is discussed in my 'Archives,' vol. iv. The bundle in the central part of the papilla consists of dark-bordered fibres, which frequently cross and interlace with one another in this part of their course. They vary much in diameter, some being so fine as scarcely to be visible.

As the bundle passes towards the summit of the papilla, the individual fibres divide and subdivide into finer branches. Now, as I have before remarked, nerves so near their distribution as these do not usually possess an axis-cylinder as a structure distinct from the white substance. The white substance does not abruptly cease, while the axis-cylinder is alone prolonged onwards by itself as is often described, but the entire fibre divides and subdivides. In fact dark-bordered nerve-fibres, near their ultimate ramifications, always consist of fatty albuminous material embedded in a transparent matrix of connective tissue. The "tubular membrane," "white substance," and "axis-cylinder" can never be demonstrated as distinct structures near the peripheral distribution of nerves. The "tubular membrane" is nothing more than the transparent matrix in which one or more nerve-fibres are embedded.

The dark-bordered fibres divide into finer fibres about the level of the ring or half-ring of capillaries at the summit of the papilla. As the fibres are exceedingly transparent, they are usually lost from view about this point. For example, Hartmann's figures convey the idea that distinct dark-bordered fibres can be followed as high as this point, but

that they cannot be traced further. Above this spot the papilla is a little thickened and the tissue more granular, and hence it is not to be wondered at that great difficulty should have been experienced in demonstrating the further course of the nerves, or that many different views should be entertained upon the oft-debated question of the mode of ending of nerves in this situation; but it is most certain that the fibres do divide and subdivide into finer and much more transparent fibres at this point, and that these again divide and subdivide and form an elaborate plexus in the summit of the papilla, which has not been before described.

By reference to my figures, the arrangement, which is not easily described with accuracy, will be at once understood, so that a minute description of it would be superfluous.

Above the plexus *c* (Pl. II, fig. 3), and below the epithelium-like organ at the summit of the papilla (*a*), is a layer (*b*) which appears to be composed of granular matter. In my most perfect specimens, however, this "granular layer," when examined by very high powers under the influence of a good light, is seen to consist of a plexus of extremely fine fibres which interlace with one another in every direction, but which pass from the plexus above to the epithelium-like nervous (?) organ upon the summit of the papilla (Pl. I, fig. 2). I believe this granular appearance to result from the extreme delicacy and fineness of the nerve-fibres at this part of their course. In like manner the "granular matter" seen in the grey matter of the cerebral convolutions and that of the retina, results mainly from the breaking down of very fine and delicate nerve-fibres, which undergo disintegration very soon after death, unless they are subjected to special methods of preparation.

Of the existence of the elaborate network of nerve-fibres with the large nuclei, represented in Pl. II, fig. 3, *c*, there can be no question whatever; but there may be some difference of opinion regarding the exact relation of the very fine nerve-fibres at the summit of the papilla, to the peculiar cells which surmount it, and the ultimate ramification of the fibres of the elaborate plexus just described. However, there are but two possible arrangements:

1. That the nerves form a network of exceedingly fine fibres upon the summit of the papilla, upon which the bases of the epithelium-like cells impinge.

2. That the very fine nerve-fibres are really continuous with the peculiar and epithelium-like cells; in which case these bodies must be regarded as part of the nervous apparatus.

There seems to me to be so much strong evidence in favour of the last view, that I venture to express a decided opinion that this is the truth. In many specimens I have seen, and most distinctly, the delicate network of fibres represented in Pl. II, fig. 3, continuous with the fine nerve-fibres in the summit of the papilla, and I have demonstrated the continuity of these fine fibres with the matter of which the outer part of these peculiar cells consists (Pls. I & II, figs. 2, 3, 6). I have also seen what I consider to be nerve-fibres in the intervals between some of these cells (fig. 7). Upon the whole I am justified in the inference that there is a structural continuity between the matter which intervenes between the masses of germinal matter at the summit of the papilla and the nerve-fibres in its axis, and I consider that an impression produced upon the surface of these peculiar cells may be conducted by *continuity of tissue* to the bundle of nerve-fibres in the body of the papilla. These peculiar cells in the summit of the papilla cannot therefore be regarded as epithelium, and the mass constitutes a peculiar organ which belongs, not to epithelial structures, but to the nervous system.

Although there can be no doubt whatever as to the existence of an intricate and exceedingly delicate nervous network or plexus at the summit of every papilla, such a plexus might be connected with the nerves according to one of two very different arrangements:

1. The plexus might be formed at the extremity of a nerve or nerves, as represented in diagram (Pl. IV, fig. 17).

2. The plexus might form a part of the course of a nerve or nerves, as represented in diagram (Pl. IV, fig. 18).

If the first be true, the network must be terminal, and impressions must be conveyed along the fibre, of which the plexus is but the terminal expansion, direct from periphery to centre. If the second arrangement is correct, the network forms a part of a continuous circuit or of continuous circuits. I believe the division of the nerves at the base of the papilla, already adverted to, is alone sufficient to justify us in accepting the second conclusion as the more probable; but when this fact is considered with reference to those which I have adduced in my paper published in the 'Transactions' for 1863, and that in the 'Proceedings' for June, 1864, and the observations published in several papers in vols. ii, iii, and iv of my 'Archives,' and in the Croonian Lecture for 1865, I think the general view in favour of complete circuits is the only one which the anatomical facts render tenable. The mode of branching and division of trunks and individual fibres is represented in Pl. IV, figs. 20, 21, 22, 23.

From the number and size of the nerve-fibres constituting the bundle in the centre of the papilla, we should infer that the finest ramifications resulting from the subdivision of these branches would be very numerous, since it has been shown that the fine fibres resulting from the subdivision of a *single* dark-bordered fibre in the frog's bladder, palate, skin, and muscle, constitute plexuses or networks which pass over a very extended area. The mode of formation of a nerve-plexus is represented in Pl. III, figs. 11 and 14. In these beautiful little organs the numerous fibres resulting from the subdivision of the dark-bordered fibres are distributed over a comparatively small extent of tissue, forming the summit of the papilla. Still, we have the same formation of plexuses, the constant change in the direction taken by fibres, and the same crossing and intercrossing which have been noticed in other situations. In fact, the nerve distribution in these organs presents the same typical arrangement as is met with in other tissues, but it is compressed into a very small space.

Now, with regard to the epithelium-like structure upon the summit, it has been shown that the nerve-fibres are probably continuous with the material lying between the large nuclei. In fact, if the interpretation of the appearances which I have given be correct, the arrangement may be expressed thus:

The material marked *a* (Pl. I, fig. 2) is a continuation of the nervous structure or tissue, while the matter marked *b* bears the same relation to this as the so-called nucleus of a nerve bears to its fibre, or that of an epithelial cell to its wall. If this be so, the matter which is freely exposed at the very summit of the papilla is at least structurally continuous with nerve-tissue, if it is not to be regarded as nerve itself. My own opinion is that it is just as much nerve-tissue as a fine nerve-fibre is nerve-tissue, or the caudate process of a nerve-cell is nerve-tissue. The formed matter is produced by the large masses of germinal matter which are so very numerous, just as the formed matter of a central nerve-cell results from changes occurring in its germinal matter.

It may not be out of place here to consider how the elaborate organ connected with the bundle of nerve-fibres of the papilla may act during life. As already stated, the free surface is uneven, and the arrangement is such that there are many elevations projecting, like fibres, by slightly varying distances, from the general surfaces. Now, from the intricate interlacement of the nerve-fibres in the summit of a papilla, as well as at the point between this and the peculiar organ (Pl. II, fig. 3, *b*), it is obvious that a fibre given off from one

There s
favour of t
opinion tha
seen, and n
presented i
fibres in the
the continui
the outer par
3, 6). I hav
the interval
the whole
structural co
between the
papilla and
an impressio
cells may be
of nerve-fibres
cells in the su
garded as epit
organ which be
nervous system.

Although ther
ence of an intric
work or plexus a
might be connecte
very different arran

1. The plexus mi
or nerves, as repres

2. The plexus mig
or nerves, as represen

If the first be true, t
pressions must be conv
plexus is but the termin
to centre. If the second
forms a part of a continuou
I believe the division of
already separated

coming from the retinæ left of the papilla, for example, may be situated a very short distance from a fibre coming from the opposite side. Any object, therefore, which connects the retinæ, projecting would produce a temporary disturbance in the nerve-centres which are traversing those fibres, and the alteration in the current would, of course, produce a change in the cells or cells which form part of the same circuit as the nerve-centre. Any strong pressure would influence all the fibres distributed to the infinite nervous organ.

The supposed mode of action is explained by the plate [illegible]

[illegible] resulting upon the capillary vessels, in the connective tissue, and upon the muscular fibres.

[illegible] of the so-called connective tissue corpuscles, with the contracting processes or "tubes," are really nerve-cells and not the mere appendages as has already been [illegible] by Schwann in his classical work. In the tongue [illegible] have followed these fibres in very many specimens. [illegible] of nerves and nerve-cells prepared on [illegible] glycerine, or other such medium available in all [illegible] countries.

[illegible] fig. 1, one of these fine branches, [illegible] bundle of pale-bordered fibres, is represented as [illegible] by a few points; this might be [illegible] of connective tissue; but it really consists [illegible] fibres which, in their arrangement [illegible] resemble those of a nerve-ramifying [illegible] figs. 2, 3, 4, 5). The fine branches [illegible] and the finest fibres resulting from [illegible] have very long diameters. The [illegible] fibres are very long and [illegible] with very small [illegible]

[illegible] Cross [illegible] in favour of [illegible] anatomical facts [illegible] and [illegible] in D[illegible]

y same set of central cells as that from which the vas-
tor fibres take their rise. It is through these fibres that
anges in the nutrition of the tissues may affect the circula-
n in the neighbouring vessels.

In these fungiform papillæ, then, there are—

1. The bundle of nerve-fibres which is destinated to the
nsitive nervous organ at the summit.

2. Delicate fibres which may be traced to fibres running in
the same bundles as purely sensitive fibres. These delicate
fibres are distributed—

a. Around the capillaries of the papilla (Pl. I, fig. 1, a).
See also Pl. III, fig. 15.

b. Some fibres ramify in the connective tissue of the
simple papillæ (Pl. I, fig. 1).

c. Some are distributed to the muscular fibres (figs. 1
& 9).

Now, the first and second fibres are probably sensitive,
ry, or afferent, whilst the last must be motor. From this
vation it follows that certain afferent and motor fibres
timately related at their distribution, a conclusion
arrived at in my investigations upon the distribution
erves to the frog's bladder, the palate, and pharynx.
er, I think that fibres passing from the plexus of senso-
s at the summit of the papilla, establish here and
structural continuity between these and the fibres
in the connective tissue and around the capillary
It is very difficult to obtain a specimen which
perfectly certain, but I have been led to a similar
n investigations upon the corpuscula tactûs of the
et. The physiological interest and importance of
anatomical inquiry are so great, and it pro-
to such important results, that it cannot be too
patiently worked out.

Of the Muscles.

bres of the papill b) are the
muscular fibr ce of the
excellent g striped
branch h of an inch
ct transverse
y cease, and the
in the connective
e arrangement will be
n.
of germ in con-

coming from the extreme left of the papilla, for example, may be situated a very short distance from a fibre coming from the opposite side. Any object, therefore, which connects the exposed projections would produce a temporary disturbance in the nerve-currents which are traversing these fibres, and this alteration in the current would, of course, produce a change in the cell or cells which form part of the same circuit in the nerve-centre. Any strong pressure would influence all the fibres distributed to this delicate nervous organ.

The supposed mode of action is explained by the plan (Pl. II, fig. 4).

Nerve-fibres ramifying upon the capillary vessels, in the connective tissue, and upon the muscular fibres.

Many of the so-called connective-tissue corpuscles, with their anastomosing processes or "*tubes*," are really nerve-nuclei and very fine pale nerve-fibres, as has already been shown in observations upon the frog's bladder. In the tongue I have followed these fine fibres in very many specimens. They can only be seen and traced in specimens prepared in syrup, glycerine, or other viscid medium miscible in all proportions with water.

In Pl. I, fig. 1, *f*, and in fig. 8, one of these fine branches, coming off from a bundle of dark-bordered fibres, is represented. Now, if examined by a low power, this might be mistaken for a fibre of connective tissue; but it really consists of several very fine fibres, which in their arrangement exhibit the same peculiarities observed in nerves ramifying in larger trunks (Pl. IV, figs. 20, 23). The fine branches divide and subdivide, and the delicate fibres resulting from their division can be followed for a very long distance. The finest are composed of several finer fibres, and they form networks or plexuses, the meshes of which vary much in size.

The branches which are distributed around the capillaries, in the connective tissue, and to the muscular fibres, seem to result from the division and subdivision of the same fibres (Pl. I, fig. 1).

Nerves which are constantly distributed external to the capillary vessels and in the connective tissue have been demonstrated by me (Pl. III, fig. 15) (see 'Archives,' vol. iv, p. 19). I consider these fibres as the afferent fibres through which an impression conveyed from the surface or from the tissues around capillaries influences the motor nerves distributed to the small arteries from which the capillaries are derived. It is probable that these nerve-fibres pass to the

very same set of central cells as that from which the vaso-motor fibres take their rise. It is through these fibres that changes in the nutrition of the tissues may affect the circulation in the neighbouring vessels.

In these fungiform papillæ, then, there are—

1. The bundle of nerve-fibres which is distributed to the sensitive nervous organ at the summit.

2. Delicate fibres which may be traced to fibres running in the same bundles as purely sensitive fibres. These delicate fibres are distributed—

a. Around the capillaries of the papilla (Pl. I, fig. 1, *i*). See also Pl. III, fig. 15.

b. Some fibres ramify in the connective tissue of the simple papillæ (Pl. I, fig. 1).

c. Some are distributed to the muscular fibres (figs. 1 & 9).

Now, the first and second fibres are probably sensitive, excitor, or afferent, whilst the last must be motor. From this observation it follows that certain afferent and motor fibres are intimately related at their distribution, a conclusion already arrived at in my investigations upon the distribution of the nerves to the frog's bladder, the palate, and pharynx. Moreover, I think that fibres passing from the plexus of sensitive fibres at the summit of the papilla, establish here and there a structural continuity between these and the fibres ramifying in the connective tissue and around the capillary vessels. It is very difficult to obtain a specimen which renders this perfectly certain, but I have been led to a similar conclusion in investigations upon the corpuscula tactûs of the human subject. The physiological interest and importance of this branch of anatomical inquiry are so great, and it promises to lead to such important results, that it cannot be too minutely or too patiently worked out.

Of the Muscles.

The muscular fibres of the papilla (Pl. I, fig. 1, *h*) are the continuations of muscular fibres in the substance of the tongue. They are excellent examples of branching striped muscle. The finest branches are less than $\frac{1}{5000}$th of an inch in diameter, but these exhibit the most distinct transverse markings. The markings, however, gradually cease, and the fibre becomes a mere line, which is lost in the connective tissue at the summit of the papilla. The arrangement will be understood if figs. 1 & 9 be referred to.

The so-called nuclei or masses of germinal matter in con-

nection with these fine muscular fibres present several points which will well repay attentive study. These masses of germinal matter are sometimes twice or three times the width of the fibre with which they are connected. In a paper published in Part XIV of my 'Archives' I have adduced facts which render it probable that these nuclei or masses of germinal matter change their position in a very remarkable manner during life.

The conclusions I have arrived at upon this point are as follows:

The masses of germinal matter appear to move along the surface of the already formed muscular tissue, and as they move part of their substance becomes converted into muscle (Pl. III, fig. 13). It is in this way that new muscle is formed and new muscular tissue is added to that already produced. The germinal matter itself does not diminish in size, because it absorbs as much pabulum as will compensate for what it loses of its own substance by conversion into tissue. In the young muscle the nucleus increases in size.

From what I have observed, I think that these oval masses of germinal matter move in different directions, but always in a line with the fibrillated structure, so that in a muscle some will be moving upwards, some downwards; and when the nuclei are arranged in rows or straight lines, the nuclei lying in adjacent lines will be moving in opposite directions. During the formation of a muscle these masses undergo division in two directions, longitudinally and transversely. The two masses which result from the division of one will pass in opposite directions.

As is well known, the position of these nuclei with respect to the formed muscular tissue is very different in different cases. Sometimes they are in the very centre of the elementary fibre, as in the constantly growing fibres of the heart, sometimes upon its surface only, sometimes distributed at very equal distances throughout its substance. Wherever these nuclei are situated, new muscular tissue may be produced, and it is only in these situations that muscular tissue ever is produced; so that by the position of the nuclei we learn the seat of formation of new muscle at different periods of life.

The facts which I regard as favorable to the view above expressed concerning the movements of the masses of germinal matter of muscle, are derived from many sources, but I will refer to some observed in the case of the muscles of the papillæ of the tongue. Here the muscular fibre is very thin and delicate, and very favorable for observation. The mass

of germinal matter is very much wider than the muscle. Often three or four of these masses are seen close together (Pl. II, fig. 9), while for some distance above and below the muscular fibre is destitute of nuclei. The narrowest extremity of the oval mass is directed in some cases towards the terminal extremity of the muscle, in others towards its base. There are often three or four fine fibres branching off from one stem, and gradually tapering in fine threads towards their insertion at the summit of the papilla (figs. 1 & 9). The nuclei are three or four times as wide as these fibres. The greatest difference is observed in the distance between contiguous nuclei connected with the very same fibre. If the muscle had gone on growing uniformly in all parts since the earliest period of its development, the nuclei would be separated from one another by equal distances, or by distances gradually but regularly increasing or diminishing from one extremity of the fibre towards the other.

I think the irregular arrangement of the nuclei in these muscular fibres of the tongue is to be accounted for by their movements. Perhaps, of a collection of these nuclei close together, two may be moving upwards towards the narrow extremity of the muscle which is inserted into the connective tissue, while the third may be moving in the opposite direction.

In some instances a "fault" is observed in the production of the muscular tissue, as if the nucleus had bridged over a space and formed a thin layer or band of muscular tissue, which, when fully formed, was separated by a narrow space or interval from the rest of the muscle. See Pl. III, fig. 12.

In cases in which the nuclei are distributed at intervals throughout the muscular tissue, as in the large elementary fibres of the muscles of the frog, the formation of the contractile material gradually ceases as the elementary fibre attains its full size. When this point has been reached some of the nuclei gradually diminish in size, and their original seat is marked by a collection of granules. These granules are sometimes absorbed, and the seat of the original nucleus is marked by a short line which gradually tapers at the two extremities until it is lost.

It is almost needless to say that no alteration produced by the different contractions of the muscle in different parts, would account for the position of the nuclei observed in the fine fibres of the papillæ of the frog's tongue.

These views, it need scarcely be said, differ entirely from those generally entertained upon the development and formation of muscular tissue. They are supported by detailed

observations made in all classes of animals, and in the same species at different periods of age. There are some facts in connection with the changes occurring in disease which afford support to this view, which involves three positions. That in the nutrition of muscle the pabulum invariably becomes converted into germinal matter; that the latter undergoes change, and gradually becomes contractile tissue; and that all the contractile material of muscle was once in the state of the material of which the nuclei or masses of germinal matter are composed. It is not deposited from the blood, nor produced by the action of the nuclei at a distance, but it results from a change in the very matter of the nucleus itself. The manner in which this occurs has been already discussed in the paper above referred to ('Archives,' No. XIV). It was shown that the oval nucleus could be followed into a very fine band of contractile tissue or fibrilla (Pl. III, fig. 13). We pass from the matter of the nucleus into very transparent imperfectly formed tissue in which no transverse lines are perceptible, and from this into fully developed contractile material in which the characteristic transverse markings are fully developed.

Of the Capillaries.

The capillaries of the papilla of the frog's tongue are remarkable for their large size. In the common frog there is a complete vascular ring at the summit of the papilla, through which the bundle of nerve-fibres distributed to this part pass. In the Hyla the same is observed in some of the papillæ, but the more common arrangement may be described as a half ring or a simple loop, bent upon one side at its upper part (Pl. I, fig. 1).

When the large capillaries of the papilla are distended with transparent Prussian-blue injection, their walls are seen to be of extreme tenuity and transparency. Connected with the transparent tissue are numerous oval masses of germinal matter (nuclei), which are separated from one another by very short intervals. Some of these masses project slightly from the inner surface of the vessel into its interior, but the majority seem to be upon its external surface. Of an oval form, many of these latter gradually taper into thin fibres which are continuous with the tissue of which the vascular wall is constituted. The delicate membrane constituting the vascular wall exhibits longitudinal striæ, which are probably produced in its formation, and by its external surface is connected with the delicate connective tissue which forms, as it were, the basis-substance of the papilla, and intervenes

between all the important tissues which are found in it. This is proved by the fact that the vessel is moved when the transparent connective tissue at some distance from it is drawn in a direction from the vessel.

The most interesting point I have observed in connection with the anatomy of these vessels is the existence of very fine nerve-fibres. These form a lax network around the capillary. I have traced these fine fibres continuous with undoubted nerve-trunks in many instances, and have followed the latter into the trunks of dark-bordered fibres, from which the bundle in the papilla is derived. A similar arrangement of fine nerve-fibres has been demonstrated in connection with other capillary vessels of the frog. These fine nerve-fibres are very distinct in several of my specimens.

I have indeed observed, in my paper published in the 'Phil. Trans.' for 1863, contrary to the statements of most anatomists, that capillary vessels generally are freely supplied with nerves, but the latter and their nuclei have been regarded as connective-tissue fibres and connective-tissue corpuscles; I have shown in certain specimens that, of the two fibres resulting from the subdivision of a dark-bordered fibre, one was distributed to the fibres of voluntary muscle, while the other ramified over the vessels supplying the muscle (Pl. III, fig. 15). These facts, it need scarcely be said, are of great importance with reference to determining the structure of the mechanism concerned in nervous action.

I have not succeeded in demonstrating lymphatic vessels in the papillæ of the frog's tongue.

Besides the various nuclei described, there are several round, oval, and variously shaped bodies, about the size of a frog's blood-corpuscle, which are composed principally of minute oil-globules and granules. These are not coloured by carmine. Many contain a small mass of germinal matter (nucleus) in the centre, which is, of course, coloured. In some of the smaller ones this mass of germinal matter is much larger in proportion to the entire "cell." These bodies resemble many of the fat-cells of the frog, and I think it probable they are of this nature. It is, however, possible that these masses may be altered lymph-corpuscles. The Hylæ which I examined had been for some time in confinement, and contained very little adipose tissue.

Conclusions.

1. That fine nerve-fibres ramify in the connective tissue of which the simple papillæ are composed, and that connected

with these fine nerve-fibres are oval masses of germinal matter or nuclei, which, with the fine nerve-fibres themselves, have been usually regarded as "connective-tissue corpuscles."

2. That neither the epithelial cells of the frog's tongue generally, nor those covering the simple papillæ, are connected with nerve-fibres.

3. That the mass consisting of epithelium-like cells upon the summit of the fungiform papilla is connected with the nerve-fibres, but it is not an epithelial structure.

4. That the dark-bordered sensitive fibres constituting the bundle of nerves in the axis of the papilla divide near its summit into numerous very fine branches, with which nuclei are connected. Thus is formed a plexus or network of exceedingly fine fibres upon the summit of each papilla; from this network numerous fine fibres may be traced into the special *nervous* organ, composed of epithelium-like cells upon the summit, with every one of which nerve-fibres appear to be connected.

5. That the bundle of nerve-fibres distributed to a papilla always divides into two bundles which pursue opposite directions. The division of the bundle may take place just at the base of the papilla, or at some distance from it, but it always occurs.

6. That fine pale nerve-fibres pass from the same trunk of dark-bordered fibres as that which gives off the bundle of nerves to the papilla. The fine fibres ramify—

a. Amongst the muscular fibres of the tongue.

b. Upon the vessels.

c. In the connective-tissue of the tongue generally, and also in the simple papillæ.

7. That the fine 'nucleated' nerve-fibres ramify freely amongst the delicate branching muscular fibres of the papillæ, and form plexuses or networks which exhibit no nerve-ends or terminations, nor in any case does a nerve-fibre penetrate through the sarcolemma or investing tissue of the fibre, or connect itself with the nuclei of the muscle. As many of the muscular fibres are so very fine and narrow, the distribution of the nerves, and their exact relation to the contractile tissue, can be demonstrated very distinctly in the case of the muscles of the papillæ of the frog's tongue.

On certain Butterfly Scales *characteristic of* Sex.

(Second paper.) By T. W. Wonfor, Brighton.

With Plate V.

In a former paper on the above subject I endeavoured to show that in three English genera of Lepidoptera, viz., Polyommatus, Pieris, and Hipparchia, there were on the males alone, and on the upper surface of the wings, certain peculiar forms of scales, to which the names "battledore" and "plumule" have been given; these scales, I argued, might, therefore, be taken as characteristic of sex. Having continued my observations among other species of the same families of continental and tropical habitats, and obtained a confirmation of the view that wherever these "plumules" and "battledores" are found they are only on male insects, I have thought it right to lay the result of my inquiries before the microscopical world, especially as another family, the Argynnidæ or Fritillaries, must be added to the list of those where the males possess a distinctive scale, and certain species of the Polyommati and a division of the Fritillaries are found to be wanting in what may be called the male characteristic.

Commencing with the "whites," I have found, this spring, on the "black-veined white," *Aporia Cratægi* (Pl. V, fig. 1), a scale differing from those of all the other whites, as will be seen by reference to the former paper. This butterfly lepidopterists have placed in a separate division of the Pieridæ, to which the name Aporia has been well given, in allusion to the apparent freedom from scales, and the almost transparent nature of its wings; this insect completes the British Pieridæ in which I have been able to detect "plumules."

Turning to tropical Pieridæ, *Pieris Larima* (fig. 2), an African form of the large-white, presents a "plumule," as might be expected, somewhat resembling that of *P. brassicæ*, but at the same time of a more delicate form, and terminated by a triangular fringe. This is a much more difficult object to resolve, as far as the scale markings are concerned. *Pieris Pigea* (fig. 3), a Chinese insect, exhibits a well-marked variety of scale. *Pieris Epicharis* (fig. 4), a very beautiful Asiatic insect, common in most collections and cases sent to this country, presents not only a peculiarly shaped scale, but has also an enormously developed bulb. Perhaps the most peculiar scale I have met with among the Pieridæ is that belonging to *P. Agathina* (fig. 5), an insect from the

island of Java, in which, while the ball-and-socket appendage is present, the fringe is wanting. Some who have seen this scale have compared it to a lobster-pot, for the top of the scale is hollow, the points not meeting and closing as in other scales; this is figured from a slide prepared by Norman, of the City Road. Fig. 6 is from *Anthocharis Danai*, a tropical representative of the English *Orange-tip*. The majority of the members of this group have a patch of bright-red or orange on the tips of the anterior wings, while the under side of the posterior wings is beautifully marked with green and pearl-white. Fig. 7 is from *A. Antevippe*, and fig. 8 from *A. Evippe*, two African members of this group.

Many other examples might be given, but a sufficient number have been adduced to show that through the family of the Pieridæ, in the *males alone*, are found scales of a certain type differing in the different species, but whether sufficiently distinct from each other as to make them available for determining species seems doubtful. Though, as has been seen, the fringe or tassel-like termination is not present in all the Pieridæ, yet they all appear to have the peculiar ball-and-socket-like bulb at the base of the scale.

Among the Polyommati all the continental and tropical species of the "blues" *proper*, which I have been able to obtain, exhibit some modification of the "battledore" scales figured by microscopists. I have figured those found on blues, which, though common on the continent, have but seldom been taken in Britain, and are, therefore, at present not classed as British insects. They are *P. Dorylas* (fig. 9), *P. Argus* (fig. 10), and *P. Œgon* (fig. 11). A male of this last has been taken near Brighton this season by a boy, and therefore has as great a claim as *P. bæticus* to be considered British. I have used the term "blues" *proper* advisedly, for strange though it appear, the "battledore" is found only on those males of this group which have *blue* or *bluish* wings. It would seem that when, as regards colour, the males resemble in personal appearance the females, they are without what I call another male characteristic. As was mentioned before, the males of the *blues* proper are of some shade of blue, while the females are brown and only dashed or spotted with that colour. Other species are of brown hue and without the blue scales, and among these the males, as far as my observations are concerned, do not possess any peculiar scale. Mr. J. Watson, of Manchester, who has been working on plumules and battledores, remarks, "No species, however, the males of which are brown, yields these scales;" and he has found battledores on 121 species belonging to this group.

The Fritillaries, or at least that division of them in which the underside of the wings is marked with metallic spots, present tasselled scales of a very decided character, differing essentially from those of the Pieridæ, on the one hand, and from the Hipparchiæ, which they somewhat resemble, on the other. Some are of a very long, narrow, and ribbon-like form, with the tassel at the apex, while others are shorter and broader. Their position on the wings differs from that of the other groups, for, instead of being placed in rows beneath the ordinary scales, they are situated on the nervures, or black veins of the upper surface, and are mingled in some species with scales or hairs of a unique shape. Fig. 12 is from *Argynnis Aglaia* (dark green fritillary); fig. 13, *A Paphia* (silver-washed fritillary), on which are found also the Indian club-like scale or hair (fig. 14). *A. Adippe* (fig. 15, high brown fritillary), and figs. 16, 17, and 19, are from foreign fritillaries, in the last of which the scale (fig. 18) is also found. It is strange, too, the difference of opacity in these scales; for while with the exception of the *apices*, which in all are nearly transparent, figs. 12 and 19 are opaque in the basal half, fig. 15 in the upper half, figs. 13 and 17 in the whole of the ribbon, and fig. 16 for four fifths of its length.

While examining the wings and scales of butterflies, and watching the escape of some hundreds of butterflies and moths from the pupa cases, I have been struck by several points, some of which are worthy the consideration of microscopists. First, the almost endless variety of shape of the scales among the Lepidoptera; some of the most common forms are figured in all books on the microscope, but there is room for plenty of work in this direction. The colour of scales is not only of almost every shade possible, but when viewed *in situ*, if the stage be rotated, as great a change of colour will be often seen as with polarized objects; some colours (as, for example, the green in the orange-tip), prove on examination to be yellow and black scales intermingled. Again, when scales are viewed as transparent objects, the colour in the majority either vanishes or becomes a dull yellowish brown. Hence arises the question, To what is the colour due? Many circumstances lead to a belief that the scales can be inflated, and that the insects possess not only the power of inflation at will, but also of raising the rows of scales. I have often caught and killed butterflies in which the rows of scales, instead of lying flat, were at an angle to the wing membrane. From this I have inferred that the insects possessed the power of rendering themselves more buoyant. I do not think the "battledores" or

"plumules" have much to do with rendering their male owners more vigorous on the wing, for I have generally found the rule to be greater activity and speed among the females. The markings, too, are very varied; and though much has been done in this direction, much more remains to be worked out. The last point has reference to the way in which the wings expand and the scales are drawn out when an insect escapes from the pupa case. Some have thought that each scale expanded in size along with the wing-membrane itself, the air breathed by the newly developed insect entering between the two laminæ, and causing their enlargement; others, that they depended on the age and vigour of the insect; in fact, being small in the newly developed, and of full size in one of mature age—assuming, what is not the case, increase in size as the insect becomes older. If a portion of that part of the pupa case which covers the wing be removed a day or two before an insect escapes, it will be found the scales are *all of full size;* or if a wing of a newly escaped insect be taken before the wing has time to expand, it will be seen that the scales are not only of *full size,* but packed closely together both laterally and longitudinally, as fig. 20. As the wing-membrane expands, the rows of scales are drawn further and wider apart, until they present the appearance seen in a fully-developed wing (fig. 21). There is, therefore, literally *no growth of scales after the insect emerges from the pupa case,* but simply a lateral and longitudinal opening out, or double telescopic unfolding of the wings. Fig. 22 represents the actual size of the wing of the large white *P. brassicæ* when emerging from the pupa case; fig. 23 shows the full-sized wing of the same butterfly. An analogous state of things is seen in the leaves of some plants having scales or hairs, notably in the case of the *Deutzia scabra,* whose stellate scales are well known. If one leaf of an unexpanded bud be removed, the stellate scales will be found of *full size,* but so crowded as to completely cover the leaf; if either a fully-formed leaf be taken, or the leaf opposite to that removed be allowed to grow, the scales will be found not to have increased in size, but only to be more widely separated by the lateral and longitudinal expansion of the leaf itself.

Description *of an* Entomostracan *inhabiting a* Coal Mine. By G. Stewardson Brady, C.M.Z.S., &c.

With Plate VI.

The interest attaching to the little animal here described lies chiefly in the peculiarity of its habitat. The members of the order Copepoda, to which it belongs, are widely distributed, inhabiting in vast numbers both fresh and salt water. They occur abundantly in lakes, ponds, and ditches, where they are chiefly represented by various species of the genera Cyclops, Diaptomus, and Canthocamptus; in brackish water by Temora, Tachidius, &c.; and in the sea by a large number of families and genera of free-swimming habits. But besides these there is a large group of species which are entirely parasitic, being found in the branchial cavities of Ascidians and in other analogous situations. But the species now under notice was found living under circumstances widely different from any of these. The roof of a part of the workings of Cramlington Colliery is kept constantly wet by the percolation of water from above, and here, amongst a slimy, gelatinous, vegetable growth, consisting apparently of imperfectly developed algæ, such as Chætophora (?), this little creature lives and multiplies. In anatomical structure it does not depart very widely from the genus Canthocamptus, under which I have here placed it; but there is great difficulty in accurately ascertaining the structure of the limbs and maxillary organs of animals so minute as this, and of which no great supply of specimens is easily attainable. The position here assigned it must, therefore, be looked upon as merely provisional.

Order.—Copepoda.

Family.—Harpactidæ.

Genus.—Canthocamptus.

Canthocamptus cryptorum, nov. sp.

Body slender, gradually tapered, the cephalothorax not very much stouter than the abdomen; first segment equal in length to the following five; superior antennæ eight-jointed, those of the *female* (Pl. VI, fig. 2) slightly tapering from base to apex, somewhat constricted at the fifth joint; joints not much differing in length, fifth and seventh rather the shortest, sparingly setose, and having no distinct flagellum; two long setæ from the upper margin of the second joint, five or six from the third, one or two from the fourth, fifth, sixth, and

seventh, and about six from the apical joint, two of which are much longer than the rest.—First four joints of the upper antennæ of the *male* (fig. 3) stouter than the rest, the fourth swollen and bearing six or eight setæ, penultimate joint very short, last joint bearing four short terminal setæ. Inferior antennæ (fig. 4) bi-articulate, bearing a short secondary branch. Lower foot-jaw (fig. 5) weak, chelate, terminal claw slender and slightly curved. First pair of feet (fig. 6) two-branched, both branches tri-articulate, and of nearly equal length; terminal joints the longest, basal joint of the inner branch bearing round its distal margin a spinous fringe; terminal joint scarcely twice as long as the middle one, and armed with one short and one very long apical seta, the middle joint having one seta at its apex; the terminal joint of the outer branch has two long but unequal apical setæ, one strong spine, and on the outer margin two short and one rather longer spine; the preceding joints are armed with a similar arrangement of spines. Inner branch of second pair of feet (fig. 7) uni-articulate, with two long and equal apical and several shorter marginal setæ. Third and fourth pairs of feet (fig. 8) longer, but in other respects nearly similar to the second; the arrangement of the setæ of the inner branch is, however, slightly different; the outer branches of the second, third, and fourth pairs are three-jointed, the middle joint in the second pair is, however, much shorter than the others, while in the third and fourth pairs the last two joints are long and nearly equal, the first being the shortest. Fifth foot laminar composed of two segments (fig. 9), each of which is fringed with long ciliated setæ. Terminal abdominal segments short; tail-setæ finely plumose, more than half the length of the body. The lower border of the last abdominal ring between the two caudal segments (fig. 10) is strongly pectinated. Eyes wanting (?). Length (exclusive of tail-setæ), $\frac{1}{4\frac{1}{5}}$th of an inch.

Habitat. Roof of the low main, West Cramlington Colliery, near Newcastle.

The credit of the discovery of this species is due to my friend Mr. Thomas Atthey, of Gosforth, who kindly forwarded to me specimens, both living and mounted for the microscope.

On Vaginicola valvata.

By C. J. Muller, Esq.

With Plate VII.

In October last I found attached to filaments of a Conferva, occurring in the brackish water of a ditch draining the marsh-land at Eastbourne, numerous specimens of *Vaginicola valvata* (Pl. VII, fig. 1). Having kept them under daily observation for some time, I am enabled to furnish a few particulars of the life-history of these curious animalcules.

If a case containing a single specimen be kept sufficiently long under microscopic observation, the following phenomena will probably be witnessed. The creature, having retreated into its cell and remained for a time quiescent, with its cilia withdrawn and apparently obliterated (fig. 2), there ultimately appears at the base, just above the stalk by which it is attached to the cell, a conical fissure (fig. 3). Very soon after this has made its appearance, a wavy line of division shows itself at the upper extremity of the animalcule (fig. 4). These fissures gradually enlarge and elongate, the lower one becomes forked in appearance (fig. 5), and the two lines approximate until they meet (fig. 6). Pulsating vesicles are active on both sides of the line of fission, and in each division, at a spot marked *a* in fig. 6, a languid movement of internal cilia may be observed. The animalcule now extends itself somewhat, but without protruding from the cell; all at once it contracts itself with a jerk, and then there expand, by slow degrees, two distinct animals (fig. 7), the one being longer than the other. This action of fission occupies about one hour.

As yet, however, the upper portions of both creatures are unformed and incomplete; they are mere rounded extremities, with an obscure internal languid movement of cilia. They elongate somewhat, and, after a time, acquire a curious contorted appearance (fig. 8). While in this state the upper extremity of each begins to assume a disc-like form, the cilia increase in size and activity of movement, and, by degrees, a greater and greater portion of the tube becomes occupied; a dense, transparent fluid appears at the upper extremity, and is seen to oscillate backward and forward, under the influence of the cilia, somewhat in the manner of the balance wheel of a watch, but with a slow, steady motion. The cilia appear to be engaged in this way in shaping and constructing the upper extremity. After a time the two

animalcules suddenly jerk back into the tube simultaneously, and then again almost immediately emerge, the longer of the two with a perfectly formed upper extremity (fig. 9); the smaller one is a little later in perfecting the part. The whole process occupies about three hours.

We have not yet done, however, with our Vaginicola. After a time it will be seen that one of the two, generally the smaller one, exhibits a delicate ring or band at about one third its length from the lower extremity. Sooner or later, after enjoying life in its ordinary condition for a day or two, it will retreat into its cell and become quiescent, leaving its companion still protruding and actively engaged in feeding. The cilia at the upper extremity now become absorbed, and there grow out from the ring or band before mentioned small filaments, which vibrate slowly. In about two hours it will present the appearance shown in fig. 11. When the cilia have attained sufficient length, the body begins to wriggle about until it finally separates from its attachment in the cell. It then turns completely round, so as to bring the base foremost, and gently works its way to the mouth of the tube, where it squeezes past its companion, which still remains lolling out (fig. 12), and goes off swimming, a free and independent animal of the shape shown in fig. 13. It darts about rapidly, now fishing apparently among invisible animalcules, anon rolling along and waddling as if enjoying itself, occasionally darting off in a perfectly straight line and impinging with force upon a filament of Conferva, where it will remain for a time feeding apparently upon something found in the locality. This may go on for hours without any change in the aspect of the creature; but frequently after one of its violent bumps against a piece of Conferva it will remain at the spot, and rapidly attach itself to the same by the front extremity (fig. 14). The action of the cilia now ceases, and they appear to become gradually absorbed. In a few minutes it stretches itself out, and again rapidly contracts, as if trying whether the attachment were perfect. In about ten minutes the form has assumed that given in fig. 15. The cilia appear as a rigid fringe, looking like the teeth of a comb. Every now and then the body contracts and again expands, and on each occasion the direction of the fringe is reversed. Anon will be perceived the formation of a delicate membrane (fig. 16) surrounding the entire organism (the new tube or case). After the lapse of twelve or eighteen hours the form assumes the appearance shown in fig. 17. Cilia now begin to appear at the upper extremity, while the fringe of old cilia, which seems to serve the purpose of keeping expanded the

new case, becomes gradually obliterated. At last the upper extremity begins to develope shape (fig. 18), the ends of the new tube are displayed, the cilia at the mouth begin to play, and finally is reproduced a perfect copy of the original animal (fig. 1) in the enjoyment of independent existence and inhabiting a house of its own. In the course of time I presume this new creature will divide itself, and its companion go through the same career, establishing itself in a new home.

I have not been able to ascertain with satisfaction what becomes of the animalcule left in the tube after the migration of its companion—whether it goes on dividing itself again and again, whether it undergoes a change like its companion, or whether it gradually ceases to exist. The advanced season of the year is unfavorable for further observation at present.

In numerous instances I have found the solitary Vaginicola become filled with vacuoles, then subsequently with dark granules in active molecular motion, and which, after a time (while the animalcule is yet alive), are discharged in enormous quantity, and have the perfect appearance of Bacteria. The body then diminishes in size, becomes separated from attachment to the cell, and floats out a shapeless mass, and, to all appearance, quite destitute of life, but it does not dissolve away even after the lapse of several hours.

Where specimens exist on Conferva numerous empty cells are found, therefore it may be safely inferred that the creature habitually, after a time abandons its cell.

Monograph *of* Monera. By Ernst Häckel.*

With Plates IX & X.

* [Note by Professor E. Perceval Wright, M.D., of Dublin.—Professor Haeckel's 'Monographie der Moneren' appeared in the 'Jenaische Zeitschrift für Medicin und Naturwissenschaft,' band iv, heft 1, which was published on the 1st of May, 1868. Attention had been directed to this group by Haeckel in his 'Generelle Morphologie,' and again in his "Natürliche Schöpfungsgeschichte." The appearance of this Monograph was, therefore, very welcome to all workers in this interesting field of research. I had at first intended, at the request of the Editors, printing in this Journal a *résumé* of the principal facts detailed in this

Memoir; but I found it quite impossible to do justice to the subject in even a lengthy *résumé;* and I thought it much preferable to give a faithful translation of the Monograph, even though it were not possible to convey thereby to the reader that charming perspicuity of style that characterises the writings of Professor Haeckel. In this the Editors fully agreed with me.

The translation is the work of my friend, Mr. W. F. Kirby, one of the assistants in the Museum of Natural History of the Royal Dublin Society, and one who is well known as an accomplished Entomologist; but I have read and revised every word of it, and I believe it will be found to convey to the reader an accurate idea of the facts and reasonings of Professor Haeckel. The German scholar will recollect the difficulty of translating into English many German technical words; and considerations of expense have, in many instances, induced me to leave sentences as they were at first printed, though it would have been easy to have reduced them into better English than that in which they now appear. The matter is so good and so valuable that the language may well be forgiven. The latter portion of the Memoir will appear in the April number of this Journal.]

I.—*Historical Introduction.*

In my 'Generelle Morphologie der Organismen,'[1] I have called those forms of life standing at the lowest grade of organization Monera,[2] their whole body, in a fully developed and freely moving condition, consists of an entirely homogeneous and structureless substance, a living particle of albumen, capable of nourishment and reproduction. These simplest and most imperfect of all organisms are, in many respects, of the highest interest.[3] For the albumen-like, organic matter meets us here as the material substratum of all life-phenomena, apparently not only under the simplest form as yet actually observed, but also under the simplest form which can well be imagined. Simpler and more incomplete organisms than the Monera cannot be conceived.

Indeed, the whole body of the Monera, however strange this may sound, represents nothing more than a single, thoroughly homogeneous particle of albumen, in a firmly adhesive condition. The external form is quite irregular, con-

[1] Ernst Haeckel, 'Generelle Morphologie der Organismen,' Berlin 1866. 2 vols.

[2] *μονήρης*, simple.

[3] L. c., vol. i, cap. v, p. 135; cap. vi, p. 182; vol. ii, p. xxii.

tinually changing, globularly contracted when at rest. Our sharpest discrimination can detect no trace of an internal structure, or of a formation from dissimilar parts. As the homogeneous, albuminous mass of the body of the Moner does not even exhibit a differentiation into an inner nucleus and an outer plasma, and as, moreover, the whole body consists of a homogeneous plasma, or protoplasma, the organic matter here does not even reach the importance of the simplest cell. It remains in the lowest imaginable grade of organic individuality, as that of one of the simplest of the Gymnocytodes.

The question which has been so often debated during the last twenty years as to a boundary between the animal and vegetable kingdoms will be decided by the Monera, or, more correctly, they will prove that a perfect separation of both kingdoms, in the manner in which it is usually attempted, is impossible. The Monera are apparently such peculiar organisms that they can be classed with equal propriety, or rather with equal arbitrariness, as primitive animals or as primitive plants. They may just as well be regarded as the first beginnings of animal as of vegetable organization. But as no one mark of distinction inclines them more to one side than to the other it seems most correct at present to class them as intermediate between true animals and true plants; and to assign them with the Rhizopoda, Amœbæ, Diatomaceæ, Flagellata, &c., to that ill-defined kingdom between the animal and vegetable kingdoms which I have called the kingdom of primitive forms, or Protista.[1]

The Monera are indeed Protista. They are neither animals nor plants. They are organisms of the most primitive kind: among which the distinction between animals and plants does not yet exist. But the term "organism" itself seems scarcely applicable to these simplest forms of life; for in the whole conception of the "organism" is especially implied the construction of the whole from dissimilar parts,—from organs or limbs. At least, two separate parts must be united to complete the description of a body as an organism in this original sense. Every true Amœba, every true (*i. e.*, nucleus-including) animal and vegetable cell, every animal-egg, is, in this sense, already an elementary organism, composed of two different organs, the inner nucleus and the outer cell-matter (Plasma or Protoplasma). Compared with these last the Monera are strictly "organisms without organs." Only in a physiological sense can we still

[1] τὸ πρώτιστον, the first of all, primordial. 'Generelle Morphologie,' vol. i, pp. 203, 215; vol. ii, p. xx.

call them organisms; as individual portions of organic matter, which fulfil the essential life-functions of all organisms, nourishment, growth, and reproduction. But all these different functions are not yet limited to different parts. They are all still executed equally by every part of the body. If the natural history of the Monera is already, on these grounds, of the highest interest as well for morphology as for physiology, this interest will be still more increased by the extraordinary importance which these very simple organisms possess for the important doctrine of spontaneous generation, or archegony. I have shown in my 'General Morphology' that the acceptation of a genuine archegony (once or repeated) has at present become a logical postulate of scientific natural history. Most naturalists who have discussed this question rationally believed that they must designate simple cells as the simplest organism produced thereby, from which all others developed themselves. But every true cell already shows a division into two different parts, *i. e.*, nucleus and plasma. The immediate production of such an object from spontaneous generation is obviously only conceivable with difficulty; but it is much easier to conceive of the production of an entirely homogeneous, organic substance, such as the structureless albumen-body of the Monera.

On these grounds, and on others to be hereafter discussed, it seems well at the present time, now we are just at the beginning of our knowledge of these very interesting primordial forms, to put together everything known about them. I received the first impulse to attempt this monograph from a series of new observations on some hitherto unknown Monera, which I had an opportunity of making, in the winter of 1866—1867, on the coast of Lanzarote, one of the Canary Islands. Before detailing these observations, I think it advisable to give a short, historical sketch of the certain information hitherto published concerning Monera. I may also mention that I restrict myself entirely to true Monera, *i. e.*, to naked Plasma-bodies without nuclei, or essential organs; and that I shall pay no regard to the Protoplasta, distinguished by the possessions of one or more nuclei (Amœbæ, Arcellæ, &c.) : nor to the Rhizopoda, Siphonea, &c., distinguished from these latter by a distinct shell or membrane.

The first Moner whose natural history was fully investigated was *Protogenes primordialis*,[1] which I observed, in the spring

[1] Ernst Haeckel, "On the Sarcode Bodies of the Rhizopoda;" 'Zeitschrift für wissensch. Zoologie,' 1865, xv Bd., p. 360, Taf. xxvi, fig. 12.

of 1864, in the Mediterranean, off Nice. When swimming freely in sea-water, this moner looks like a transparent, globular particle of mucus, of about 1mm. diameter (smaller specimens measure only 0·1 mm. diameter). Only about a third of this measurement applies to the inner central portion of the body, the homogeneous solid sarcode ball, while the outer two thirds consists entirely of thousands of fine, radiating, mucous threads. These threads, the so-called pseudopods, some of which run simple and some twisted and anastomosed to the periphery, radiate immediately from the periphery of the central albuminous body. They show throughout, the same life-phenomena as the similar sarcode threads of the true Rhizopoda (Acyttaria and Radiolaria). The solidified, albuminous mass of the whole body was in continual motion, now slower, now faster, which was easy to follow by the passive movements of the fine and usually numerous particles scattered in the albuminous mass. The sarcode threads constantly varied in number, form, and size; they ramified and anastomosed, separated again, and were drawn back into the central, principal mass. In short, they exhibited exactly the same appearance which has been so often and fully described by Max Schultze[1] in the Polythalamia, and by myself in the Radiolaria[2]. Nourishment was also taken, by the Protogenes, in the same manner as by the last-named, true Rhizopoda. Smaller bodies (Diatomaceæ, unicellular Algæ, &c.) remained hanging on the glutinous surface of the albumen threads, if they accidentally came in contact with them, they were surrounded by them, and then slowly drawn into the central albuminous mass. Larger bodies, such as, for example, Peridiniæ (l. c. fig. 2), were finally entirely surrounded by the body of the Protogenes; afterwards, certain contents of the victim were first assimilated; and the Protogenes then immediately moved away from the indigestible shell. In a shallow watch-glass, with a little sea-water left standing for some time, the Protogenes spread itself out at the bottom in the form of a thin, hyaline, mucilaginous plate. This plate had very irregular, jagged outlines, and a diameter of from 3 to 4 mm. But the most important point which I could ascertain respecting the Protogenes was its reproduction by spontaneous fission. This was accomplished by a simple division of the globular, mucilaginous body into

[1] Max Schultze, 'On the Organism of the Polythalamia,' Leipsig, 1854, p. 17.

[2] Ernst Haeckel, 'Die Radiolarien, eine Monographie,' Berlin, 1862, p. 86.

special motion-

Max Schultze in the

Pseudo-

interest us

nucleus and

character of a cell.

Campyrella are true

possess neither nuclei

Monas has many signi-

have called the *Monas amyli*,

Protomonas

the formation of sporules had been observed. The homogeneous plasma body of this species lives in decaying Nitellæ, and resembles a small Actinophrys, or a small *Amœba porrecta*, without nucleus, and without contractile vesicles. When it assumes the stationary condition, it contracts itself into a roundish plasma body, which then becomes surrounded with a membrane (encysted). Then the body breaks up into a great number of homogeneous sporules, which are spindle-shaped and very contractile, and move about with a serpentine motion, like an Anguillula, by means of one or two rather long cilia. Several sporules often adhere (by growing together), and form a plasmodium, which, after taking nourishment, returns to the stationary condition (Cienkowski, l. c. p. 213, tab. xii, figs. 1—5.)

The genus *Vampyrella* does not reproduce itself by sporules, but by two or four actinophrys-like buds. The homogeneous plasma body is distinguished by its brick-red colour. Cienkowski defines three different species of this genus. *Vampyrella spirogyræ* (l. c. figs. 44—56) forms, in the stationary condition, globular bladders, whose thin membrane encloses a homogeneous red plasma body. This separates, by division, first into two, then into four germs, which break through the outer envelope, and then move about like red Amœbæ, with pointed processes of very various form. These germs bore through the cell-walls of the *Spirogyra*, with their pointed pseudopods, whereupon they draw out the plasmic contents, and absorb them into themselves. The green contents of the former receive, by digestion, a red colour. In the same way *Vampyrella pendula* (l. c. p. 221, figs. 57—63) bores into the cells of other algæ (Œdogoniæ, Bulbochætæ), and sucks out their plasma. It is distinguished by a thread-like process, which proceeds from the plasma body of the pear-shaped cyst, through its pointed stem to the base, and by the want of granular currents in the actinophrys-like pseudopods. *Vampyrella vorax*, a third species, lives, on the contrary, on Diatomaceæ, Euglenæ, and Desmidiaceæ, which its formless plasma body envelopes, and then forms cysts of very various form and size (l. c. p. 223, figs. 64—73).

Finally, in my 'General Morphology' (vol. i, p. 133) I have described a small Amœba-like Monera, under the name of *Protamœba primitiva*, which is distinguished from the previously mentioned *Monadinæ* of Cienkowski, by reproducing itself by fission alone, without previously passing into a stationary condition, or encysting itself. In this respect it resembles *Protogenes primordialis*, from which, how-

ever, it is distinguished by the short, blunt, and non-confluent pseudopods. The more precise description of this *Protamœba* will be given below.

In the year 1866 Richard Greef observed several Monera on the coast at Ostend very similar to my *Protogenes primordialis*, and like it of considerable size. He has shown me numerous drawings, which show very great variations in form, like the plasmodia of *Myxomycetæ*. The particulars are not yet published.

As I spent three months in the winter of 1866-67 at Lanzarote, one of the Canary Islands, to make observations on the lower marine animals, my investigations were directed towards the *Hydromedusæ* and the true *Rhizopoda*, and especially to the *Monera*, and my expectations of meeting with some were not disappointed. The *Protomyxa* figured on Plate IX, and the *Myxastrum* represented on Plate X, enrich the natural history of these very simple organisms with new forms. It is probable that Monera are very widely distributed, and it is likely that they constantly arise from spontaneous generation. The greatest difficulty in searching for them is their first recognition, as most observers are not prepared to recognise in the small, formless, thoroughly homogeneous slimy atom an independent and fully developed organism. May I, therefore, warmly recommend the Monera to the special observation of microscopical observers.

II.—*Descriptions of new Monera.*

1. *Protomyxa aurantiaca.*

See Plate IX, figs. 1—12.

On many of the Coast-lines of the Canary Islands the spirally twisted calcareous shells of *Spirula Peronii* are found thrown up by the sea in large quantities. I found them, for example, heaped up in particular abundance on the south-east coast of the island Lanzarote on the small flat banks of the island, and on the isthmuses which lie before the seaport town of Puerto del Arrecife, and partially surround the harbour. During my three months' residence in Arrecife I confidently hoped to obtain living specimens of this remarkable Cephalopod, or, at least, such as would be fit for anatomical examination, as our knowledge of the softer parts of its body is extremely incomplete. I offered the fishermen of Arrecife a high reward if they would bring me a live or

even the entire dead body of a Spirula. This was just as unavailing as the many searches which my three travelling companions and I made on our marine excursions, and among the masses of Spirula thrown upon the shore. It is certain that the Spirula only reaches the Canary Islands very rarely, if at all, in a living state, since all the fishermen uniformly assured us positively that the well-known Spirula shells were always dead, and that they never enclosed or were inhabited by a living animal. All that I could procure were some white remains of the encompassing mantle, adhering to a few shells which, however, did not enable me to ascertain anything of the structure of the body of the Spirula. These unsatisfactory remains were frequently driven into the harbour of Arrecife, and on some days a strong south wind would drive ashore unusually large quantities of empty Spirula shells, along with numerous Physalia, and Velella, and other pelagic animals of the island Lanzarote.

Although my hopes respecting the Spirula itself were not fulfilled, I nevertheless found on the empty calcareous shells of this cephalopod driven ashore in January, 1867, a Protozoan organism of the Monera group, which was of the greatest interest to me, and whose life-history I have delineated on Plate IX.

As I sought carefully for some remains of a mantle still adhering to the shells, among a great quantity of Spirula shells which were floating on the surface of the harbour of Arrecife, and which I had drawn up in a bucket along with *Physalia*, *Abyla*, *Hippopodius*, and other pelagic animals, I noticed an empty Spirula shell, whose ordinary, shining porcelain-white was obscured, in several places, by small red flakes. Under a strong lens these flakes were seen to be partly in groups of thickly-placed very small red dots, and partly in extremely fine ramifying arborescent figures.

The red dots were easily detached from the surface of the Spirula shell, with needles, under the dissecting microscope. With a higher magnifying power each dot resolved itself into a tolerably opaque, orange-red ball, covered with a thick structureless membrane. The diameter of the whole body measures in most 0·15 mm., in the largest 0·2 mm., in the smallest 0·12 mm. (Pl. IX, fig. 1). The membrane of the ball appeared entire, structureless, glassy, colourless, and translucent. Only a number of (from five to ten) very fine parallel striæ were to be noticed, which ran concentrically round the centre of the ball, apparently indications of the separation of the structureless mass into layers. Radiating striæ, pore-like formations, or other openings, were not ob-

servable in the membrane of the ball. The base also by which it was attached to the Spirula shell (apparently only very loosely) showed nothing particularly remarkable. The consistence of the membrane, as far as it could be ascertained from the pressure of the overlying-glass, was that of a tolerably tough and very elastic jelly, somewhat comparable to that of the umbrella of the firmer Medusæ; for instance, those of *Trachynema* and *Rhizostoma*. Like the latter, this membrane showed itself very indifferent to reagents; it was not coloured by the application of carmine, nor by iodine and sulphuric acid. After long remaining in iodine it became of a pale yellow. Acetic acid did not much alter it, nor did any of the mineral acids. In caustic potash it swelled up and dissolved slowly.

The orange-red contents of the balls appeared in uninjured specimens within the closed, globular membrane, as a thoroughly homogeneous, consistent, obscurely granulated mass, in which might be observed very numerous, exceedingly fine particles, and a small quantity of strongly refracting red grains. On moderate compression with the stage-glass, the balls allowed themselves to be pretty strongly compressed spheroidally, and took the shape of a double convex lens of 0·3 mm. diameter. On relaxation of the pressure, they expanded again to their former globular form. The opaque centre of the balls became under pressure more transparent, without, however, exhibiting any structure.

My first impression that the balls were eggs already appeared to me wholly improbable, as there was no appearance of a germ-cell (nucleus) throughout the homogeneous contents. It was soon entirely set aside by the different stages of development exhibited by several of the balls, as well as by the behaviour of the contents when pressed out of the balls.

While in most of the balls the contents lay everywhere thickly on the inside of the membrane, and entirely filled the interior of the whole membranous envelope, in some individuals the contents were a little retracted and apparently thickened; and a space filled with a clear fluid interposed between the membrane and the thickened contents (fig. 2). In some balls the edge of the central thickened orange-red mass was a perfectly defined and regular boundary line. In others, on the contrary, it appeared to be regularly indented. There were about twenty indentations to be seen on the edge of the red ball. On examination of the surface it appeared that these indentations were the indication of a regular series of convex eminences on the entire surface of

the thickened ball. Lastly, other balls which were apparently further developed showed plainly that these indentations were not merely on the surface of the thickened contents, but were only the external sign of the breaking up of the whole globular orange-red mass into a great number of small balls. In the most developed individuals the entire orange-red contents of the balls was, indeed, divided into nothing else but small balls of 0·017 mm. These lay scarcely pressed together, and touched each other only slightly, something like a heap of cannon balls. Again, they had moved apart from each other in such a way that they no longer filled up the entire hollow of the sphere, but were much more separated from each other by a small quantity of the clear fluid which had previously collected between the hyaline membrane and the thickened contents (fig. 3). The number of small orange-red balls which resulted from the dissolution of the original large ball was about two hundred at its subsequent bursting.

Next, I attempted to arrive at a closer knowledge of the orange-red contents of the undivided balls by bursting the membrane. This was easily effected. As soon as the pressure of the covering-glass had exceeded a certain point, the membrane burst usually in one place, rarely in several at once; and the orange-red contents oozed slowly out. The hyaline structureless membrane remaining in a very wrinkled condition.

The solid contents of the balls, which had the moderate consistence of the organic plasma or protoplasma, issued from the burst fracture very slowly and gradually; and spread itself out between the stage-glass and the covering-glass, so that the edges appeared like roundish obtuse patches of dissimilar size. By cautious shifting of the covering-glass, it was tolerably easy to move the transparent shrivelled and collapsed jelly-like envelope of the burst ball on one side, so that the orange-red contents lay isolated under the covering-glass. On the application of moderate pressure, it appeared like a shapeless, roundish mass, whose edge fluctuated about in irregular projections of different size; some projections appeared to be notched. It was plain at the first glance that the whole mass was structureless and homogeneous. Only a very large quantity of the already mentioned very fine punctiform particles and a smaller number of larger globular granules were scattered through the completely homogeneous substance. The latter was throughout the whole mass of a pale reddish colour, as well as at the edge, where it only spread out as

a very thin layer. The bright orange-red colour of the whole balls was apparently chiefly caused by the orange-red and rather strongly shining granules.

The chemical examination of the pale reddish yellow structureless body substance soon showed it to be of an albuminous nature. It showed the same reactions which are presented in a similar manner by the plasma or protoplasma of Cytodiæ, and the cells of animals, protozoa and plants. Carmine coloured the whole mass dark red, iodine dark brown. Mineral acids produced a granular coagulation. Nitric acid coloured the plasma dark yellowish brown; sulphuric acid, verdigris-green. The last reaction reminded me of the similar colouring of the pigments of the Acanthometra by sulphuric acid. The larger as well as the smaller granules in the structureless ground substance were not affected by potash, while the plasma slowly dissolved in it. There was not the slightest trace of any differentiation or structure in the empty exuded plasma.

The further developed balls which contained a great quantity of little orange-red bodies, instead of the large, homogeneous plasma-ball, were also tolerably easy to burst. Their structureless envelope, however, was somewhat harder and more consistent. The orange-red contents which exuded from the burst envelope separated in water into single particles, which were easily separated from each other. The single balls were all of the same size, of 0·017 mm. diameter. They were entirely naked and uncovered, formed simply and solely of the reddish yellow plasma, in which were suspended a quantity of very fine and small shining orange-red particles. The larger reddish yellow and red globular granules, which were dispersed through the plasma of the undivided balls, were entirely absent here. They were also wanting, too, in those balls in which the furrows on the surface showed the commencement of the separation of the plasma into smaller balls. There was as little trace of a nucleus or of a contractile vesicle in the small balls as in the large undivided balls.

The small orange-red balls, which were apparently produced by the division of the one large plasma ball, showed no movement during my first examination. Instead of this, amœba-like motions soon afterwards commenced in one of the large undivided orange-red balls, which I had with great care freed from their structureless envelope, not by bursting them under the microscope by the pressure of the covering-glass, but by piercing and tearing them with two pointed needles in a watch-glass with sea water. How-

ever, these amœba-like movements were not particularly rapid and soon ceased. They were not to be compared with the rapid motions of the pretty stellar and arborescent figures which I had remarked with the orange-red balls in the white Spirula shell, and which I am just about to describe.

Examined by a low magnifier and by direct light these forms had a very pretty appearance. The opaque, shining, white porcelain-like Spirula shell looked as if it was adorned with scattered, star-shaped reddish-yellow pigment cells, like those which are so common in the skin of the lower vertebrata (fishes, amphibia). Each star-like flake contained an irregular, roundish, central mass of about 0·2 to 0·3 mm. in diameter, and a number (usually from five to ten) of large branches which radiated from the central mass, and moved very finely and prettily. On the application of a stronger power a change of form was observable both in the central mass and in the branches and their twigs, which was produced by the spontaneous contraction of the starlike body. One might have thought that he had chromatophores before his eyes on the surface of the Spirula. But no trace of a mantle remained on the completely naked, apparently long wave-tossed Spirula shell; and I therefore recognised in the prettily-streaked body a large organism allied to the Rhizopoda. In order to examine it better by reflected light it was absolutely necessary to detach it from the opaque Spirula shell. Several attempts to detach it with a fine cataract needle, or to raise it with a thin splinter of the shell itself, failed totally. I brought under the microscope only small shapeless fragments of the reddish-yellow protoplasma. I therefore laid two larger fragments of the shell which had each a reddish-yellow star adhering to them, in a shallow watch-glass with sea water which I covered with another watch-glass, and put aside in a damp room. My intention of inducing the Rhizopod to creep down succeeded with one specimen in a few hours; with two others next day; and I had now the pleasure of examining at my leisure this remarkable organism which had moved from the Spirula shell into the watch-glass, and had expanded itself here (fig. 11, 12). Each star-shaped body now showed more plainly, with the aid of a stronger magnifying power without a covering-glass, a beautiful plasma or sarcode net, as fully developed, and with as numerous meshes, as is found among the Polythalamia and Radiolaria, Myxomyceta and Lieberkuhniæ.

The central plasma mass formed a flat, transparent disc, of

irregular roundish but nearly circular outline, and of about 0·2 to 0·3 mm. in diameter. On the edge it projected from six to eight stout protoplasma stems, each of which ramified into a very slender tree. These stems, of from 0·01 to 0·03 mm. diameter at the base, forked immediately into two, rarely into three, branches, which, after running a short distance, again forked, and so on. At each division the diameter of the forked twigs was conspicuously less, so that each branch was usually not half so strong as the next stronger branch of the preceding series. The branches were nearly all slightly and delicately curved, seldom quite straight. The neighbouring branches of the third or fourth series already began to unite; and the anastomoses of the branches always became more numerous towards the periphery, so that the outer branches formed a nearly coherent, peripheral, sarcode net. The form of the anastomosis was very irregular, being towards the periphery more and more crescent-shaped, and at the basement more irregularly polygonal. On the whole, the plasma net was very similar to that which Claparède has figured in his *Lieberkuhnia Wageneri*.[1]

The reddish-yellow colour was most intense in the centre of the body; which also appeared to display the thickest layer of plasma; and in the principal stems which branched from the periphery. Near the latter the colour was always fainter; and the finest twigs seemed coloured pale reddish yellow. The colour was nowhere so intensely orange red as in the previously described balls. As in the last, the colour here also arose from a diffused reddish yellow of the structureless ground substance, as if produced by a lively yellowish-red tint of the granules therein suspended.

The central disc-shaped mass of the body, as well as the projecting branches and their twigs, were entirely transparent, and also plainly showed with the greatest clearness and under the strongest magnifier that the entire mass of the body was entirely structureless and homogeneous, without any combination of cells or cellular forms. This fact was proved by the finer and coarser red granules, which streamed here and there in the sarcode net, as well as by the foreign bodies and food (namely, Diatomaceæ) dispersed here and there in the plasma. These last were also seized like the red granules, and carried away passively by the current which was caused by the active movements of the albuminous molecules of the homogeneous plasma. In their chemical composition the albuminous bodies of the plasma or the sarcode

[1] Claparède and Lachmann, 'Etudes sur les Infusoires et les Rhizopodes' (1858), vol. i, p. 464, pl. xxiii.

were not different from those of the red balls which were previously described, and showed precisely the same reactions. The appearance of currents of the sarcode, or of the free plasma (protoplasma), particularly as they manifest themselves in the true Rhizopoda (Acyttaria and Radiolaria), have been for the last thirty-three years so carefully examined and so universally known, that it would be superfluous to re-describe it in detail in the organism before us. Dujardin[1] and Max Schultze[2] in the Polythalamia, Claparède and Lachmann in Actinophrys, Acanthometra and Lieberkühnia,[3] Johannes Müller,[4] and myself[5] in the Radiolaria, De Bary,[6] and Cienkowski[7] in the Myxomycetæ, have so consistently described and so fully figured this very interesting and important phenomena, that there can be no longer any doubt of its real existence and frequent occurrence. However, since 1862 Reichert has attempted in numerous papers to show its impossibility, and that the discoveries and observations of all the above-mentioned naturalists were false, because inconsistent with his dogmatic vitalistic ideas of nature. I have already shown in my papers on the sarcode body of the Rhizopoda the entire groundlessness and perversity of Reichert's assertions. I should not have alluded to the subject here if Reichert had not, in a recently published large treatise, himself accepted the plasma theory of the sarcode which he had attacked, and attempted so to misrepresent the matter, that he seems to represent himself as the special discoverer of the phenomenon which he formerly declared to be impossible, but which was in fact long ago fully demonstrated. The following (III) portion of my treatise will discuss this matter more particularly.

The orange-coloured Rhizopod-like organism which I found on the Spirula shell, and which I propose to designate *Protomyxa aurantiaca*, shows the phenomenon of the sarcode current in the most remarkable manner. Its reddish-yellow sarcode is to a considerable extent semiliquid, somewhat as in Thalassicola among the Radiolaria, in Gro-

[1] Dujardin, "Observations nouvelles, &c.;" 'Annales des Sciences Nat.,' 1835, 2 sér., tom. iii., p. 112, et seq.

[2] Max Schultze, l. c., p. 16, et seq.

[3] Claparède et Lachmann, l. c., vol. i, p. 416 and 464.

[4] Johannes Müller, "Ueber die Thalassicollen, Polycystinen und Acanthometren;" 'Abhandl. der Berlin Akad,' 1858, p. 3, et seq.

[5] Ernst Haeckel, 'Die Radiolarien,' pp. 89—126 and pp. 127—159.

[6] De Bary, "Die Mycetozoen;" 'Zeitschrift für wissensch. Zool.,' 1860, vol. x, p. 88, et seq.

[7] Cienkowski, "Zur Entwickelungsgeschichte der Myxomyceten"; "Pringsheims Jahrbücher für wissensch. Botanik,' iii, p. 325, et seq.

mia among the Acyttaria, or in Physarum among the Myxomycetæ. The numerous scattered red granules which are set in motion by the reciprocal movements of the disarranged plasma molecules, and are passively carried away by the active sarcode current, allowed the courses of the current to be very clearly traced. These courses have no fixed direction, and are in continual change. With the larger stream-threads one could often plainly notice a centrifugal close to a centripetal stream. The rapidity, direction, and strength of the streams varied continually. The broad polygonal sarcode patches which were easily seen to form at the anastomosis of two branches of the stream appeared and disappeared; and thus showed with remarkable clearness the thoroughly homogeneous character of the entire contractile plasma substance. Nothing could be perceived of a division into a thicker outer layer and a thinner fluid inner layer, as occurs in many Rhizopoda and Myxomycetæ.

Besides the numerous red granules, other larger foreign bodies were carried away by the sarcode current; these had been taken as nourishment, especially pelagic infusoria and Diatomaceæ, which form the chief nourishment of the Protomyxa. The individual represented at fig. 11 had devoured two Isthmiæ and three Tintinnoidæ with a siliceous network (two *Dictyocysta elegans* and one *D. mitra*), and was nevertheless already again on the point of drawing a *Peridinium* into its body. Food was taken in the same way as in the true Rhizopoda. The process of taking food could plainly be followed with free swimming Diatomaceæ, which I placed in the watch-glass containing the Protomyxa. As soon as a stretched-out plasma thread came in contact with one of these bodies, a stronger flow of plasma to this side followed. Neighbouring threads gathered round and coalesced with the first. In a short time the siliceous cell of the diatom was surrounded by a layer of protoplasma, and was now drawn into the central mass of the body by retraction of the divided plasma threads. The digestion of the prey consisted simply in an extraction and assimilation of the yellowish-brown plasma contents of the siliceous cell. The siliceous membrane of the prey did not seem to be at all affected; and the empty shell was again rejected by the contraction of the soft, central mass.

(To be continued.)

On the Colouring Matters *of* Blue Decayed Wood. By H. C. Sorby, F.R.S.

Decayed wood, coloured blue by the spawn of *Peziza ærugnosa* (see 'Quart. Journ. of Science,' V, 222) contains several colouring matters. None of these are sensibly soluble in water, but they are dissolved by alcohol with varying facility, so that they may be separated with a little care. On digesting with the aid of heat a portion of the wood in a moderate quantity of alcohol, a solution of dull neutral tint is obtained, and the wood is left of a bluer green. On agitating the alcoholic solution with bisulphide of carbon, that liquid abstracts a small quantity of a yellow colour, which does not present any facts of particular interest. The alcoholic solution is a mixture of a claret colour, very easily dissolved by alcohol, and a blue, soluble with much greater difficulty, so that, on evaporating to dryness and redissolving in a little alcohol, the blue colour is left and the claret dissolved, which may be still further purified by evaporating to dryness and redissolving a second time. It is then of a decided claret colour, with no trace of blue or green, and the spectrum shows a strong absorption at the blue end, gradually becoming less towards the red. Adopting the scale and nomenclature described in my paper in the 'Proceedings of the Royal Society,'[1] the spectrum is about $3\frac{3}{4}$...9 – – 11 —. The addition of a little ammonia turns it green, and develops an absorption band in the orange, the centre being at 3. Citric acid restores it to the original state, unless so much ammonia has been added as to produce decomposition. Sulphite of soda has no effect on an acid solution, so that the colour may be described as $C\,al_o\,am_1$ (3). I have not yet met with such a colour in any other substance.

The blue colour may be obtained in greater purity by digesting the wood several times in fresh alcohol, so as to remove all the claret colour, when at length a clear blue-green solution is obtained, which, however, is only pale. The spectrum, as seen in a tube two inches long, shows a well-marked absorption band in the red at $1\frac{1}{2}$, with a small amount of the extreme blue partially obscured. On adding ammonia the colour is changed to a dull yellow, and the band removed; but it is evidently decomposed, since citric acid does not restore it to the former state. A small quantity of nitric acid added to the original only serves to make it a

[1] 1867, xv, 433.

clearer blue. Sulphite of soda has no effect on an acid solution, and, therefore, the colour is C al_1 ($1\frac{1}{8}$). I have not yet met with this in any other substance, and it is interesting as being one of the very few blue colours soluble in water or alcohol which belong to my group C. These are as follows:

Phyco-cyan[1]	C aq_2 ($\frac{2\frac{5}{8}}{..}$ $\frac{4\frac{1}{8}}{..}$)
Blue colour from the flowers of *Salvia patens*	C aq_0 ($\frac{1\frac{7}{8}}{..}$ $\frac{3\frac{1}{4}}{..}$)
Aniline blue	C al_1 ($\frac{3\frac{1}{8}}{..}$).

When the alcoholic solution of the blue of the wood is diluted with water and agitated with ether it is precipitated from the solution, and collects at the line of junction of the water and supernatant ether; but when agitated with benzole this liquid rises to the top coloured blue. The solution may, however, be obtained in a more simple manner by digesting the wood in benzole, which dissolves more colour than alcohol, and it is of a fine green-blue tinge. The spectrum is the same as that of the alcoholic solution; but both of these fade in the course of a few days, even when sealed up in glass tubes, so that neither can be kept as a permanent object.

On the EPITHELIUM *of the* CORNEA *of the* OX. By JOHN CLELAND, M.D., Professor of Anatomy and Physiology, Galway.

(From the 'Journal of Anatomy and Physiology,' new series, No. i.)

IT is well known that there are many appearances in stratified epithelia not easily explained by that simplest theory of their growth which is naturally first suggested, and is no doubt in all instances partially true; namely, that cells originating in a deep position pass gradually to the surface as they grow and alter in figure, while those superficial to them are cast or dissolved, and others behind them follow in their steps. Thus the elliptic cells in the deeper strata of the epithelium of the trachea can scarcely be supposed to be developed into the ciliated columns which lie over them; and it cannot be imagined that in the ureter the large and irregularly shaped cells are altered so as to form the smaller and flatter cells found on the surface.

[1] Cohn, 'Archiv. für Microskopische Anatomie,' 1867.

In the cuticle, it is obvious that the horny portion is formed of cells derived from the deeper part and progressively finding their way to the surface where they are cast off; but the elongated form of the cells resting on the dermis, and the size of these as compared with those above them, shows that in this part there is another mode of growth not yet sufficiently investigated. The epithelium of the cornea, whilst it presents the same general arrangement of parts as the cuticle, is a much more delicate structure; and on account of the individual cells being more readily separated, it is much more easily examined: it may be studied without much difficulty with the aid of carmine-staining and bichromate of potash. In the human subject the deepest layer of the corneal epithelium consists of cells not more elongated, in comparison with those superficial to them, than the deepest cells of the cuticle; but in the ox, the sheep, and the horse, and probably other animals, it presents the appearance of a stratum of columnar epithelium, the cells of which are as elongated in form as those of any columnar epithelium in the body. In the ox the cells are of large size. The elongated cells now mentioned, flat at one extremity, and pointed or caudate at the other, differ from those of columnar epithelium, not only in forming the deepest instead of the most superficial layer, but in having the flat extremity resting on the subjacent parts. The whole thickness of the epithelium, when swollen by the action of the bichromate, can be easily detached from the surface of the cornea, which is left quite clear of any structure from which the epithelium could be derived; for the only nuclei which it exhibits are the long-shaped nuclei in its interior, which are totally different in appearance from the nuclei of the epithelium. When the detached epithelium is examined in vertical sections, the elongated elements forming its deepest layer are seen to lie closely together with their flattened extremities in a line, and each cell exhibiting only one nucleus, which is always at a considerable distance from the corneal extremity. Thus it is very obvious that the epithelium is not derived from the subjacent cornea, but that the cornea and epithelium are wholly independent structures adhering together.

Immediately superficial to the columnar stratum is a layer of cells of irregular shape, about twice as broad as the columnar, but by no means so elongated. They are rounded and even in outline at the superfical extremity, but are jagged at the other, sending in processes or digitations which may be three or four in number, and which appear to fit in between the tapering points of the columnar cells. The cells

Description of a Species *of* Trematode *from the* Indian Elephant, *with* Remarks *on its* Affinities. By T. Spencer Cobbold, M.D., F.R.S., F.L.S.

(Read at the Meeting of the British Association at Norwich.)

On the 24th of June of the present year I received a small bottle containing two flukes. It was accompanied by a note from Dr. Baird, F.R.S., stating that the specimens had been transmitted to him from India by Dr. Hugh Cleghorn. On the phial itself was a brief notice to the following effect:—Distoma taken from Liver of Elephant at Rangoon, forwarded for classification to Professor Cobbold by Vet.-Surgeon J. Thacker. Madras Army." This is all I know of the history of these two entozoa. On naked-eye inspection it was clear to me that they were identical in character with a larger series of specimens previously exhibited by Professor Huxley during the delivery of a recent course of lectures at the Royal College of Surgeons. Having communicated to Professor Huxley the facts as above stated, I received permission to make use of his set of specimens, originally fifteen in number, for the purposes of comparison and description. This series was placed in Mr. Flower's hands last February, and six of the individuals were subsequently selected and mounted, with the view to their being added to the valuable collection of entozoa contained in the Hunterian Museum.

The first thing to be determined is as to whether or not these flukes are new to science. In this relation, therefore, I have to remark that so far back as the year 1847, Dr. Jackson, in his 'Descriptive Catalogue of the Anatomical Museum of the Boston Society for Medical Improvement,' incidentally mentions the occurrence of flukes from the Indian elephant. Though several examples were removed from the biliary ducts and duodenum, along with many specimens of *Ascaris lonchoptera*, it does not appear that any of them have been properly described. In all likelihood (if the flukes are still preserved in the Boston Museum) it will be found that they specifically correspond with those in our possession. I may add that the late C. M. Diesing, in the appendix to his well-known 'Systema Helminthum,' had already, in 1850, noticed Jackson's statement (vol. ii, p. 560), and also subsequently in his more recent 'Revision der Myzelminthen' (p. 50). In the last-named work, which bears the date of 1858, Diesing still regarded the entozoon as a doubtfully distinct form, allowing it, however, to appear under the title of *Distomum elephantis*. In my synopsis of the Disto-

midæ, communicated to the Linnean Society in 1859, I admitted it, conjecturally, as a good species ('Proceed.' for 1860, Zoology, vol. v, p. 9). The determination has since proved correct, for it now turns out that this elephant-fluke (judging from those in our hands) is not only a distinct species, but that it differs also generically from the Distomes properly so called. In point of fact, it is a sort of transition-type between the genera Fasciola and Campula. This last-named genus I established in 1857 for a form which I found in the liver-ducts of the common porpoise; but as the species under consideration comes rather more closely to the genus Fasciola than to Campula, I shall not seek to complicate matters by adding yet another generic type. Anyhow, the nomenclature must be altered, consequently I herewith correctly name, and for the first time fully describe, the species as follows:

Fasciola Jacksonii, Cobbold.—Body armed throughout with minute spines, orbicular, usually folded at either end towards the ventral aspect, thus presenting a concavo-convex form; oral sucker terminal, with reproductive papilla about midway between it and the ventral acetabulum; intromittent organ $\frac{1}{4}''$ in length; digestive apparatus with two main zig-zag-shaped canals, giving off alternating branches at the angles thus formed, the ultimate cæcal ramifications together occupying the whole extent of the body; length, when unrolled, from $\frac{1}{2}''$ to $\frac{3}{4}''$; breadth, $\frac{1}{3}''$ to $\frac{1}{4}''$.

Supplementary Note.—In all the specimens the alimentary tubes are filled with inspissated bile, and so completely so as to supersede the necessity of any attempts at artificial injection. Examples may now be seen in the Museum of the Royal College of Surgeons.

Enumeration *of* Micro-lichens *parasitic*[1] *on other* Lichens. By W. Lauder Lindsay, M.D., F.R.S.E., F.L.S.

The Lichens to which the present communication refers constitute an increasingly large and important group—for the most part of athalline forms—whose apothecia (with or without spermogonia or pycnidia) alone represent the plant: minute in size, frequently obscure and difficult of observa-

[1] I here use the term "parasitic" in its popular sense, including both "Epiphytes" and "true Parasites," as these are defined in the recent 'Phytopathologie' (1868, p. 14) of Professor Hallier, of Jena. I cannot, however, agree with that distinguished German professor, or generally with

tion, requiring for the determination of their structure and place in classification the patient use of the microscope.[1] The group is a most heterogeneous one, comprising many genera and species that are at least anomalous:[2] that have been imperfectly studied: and that are comparatively little known. There are several advantages, I think, from bringing them together and studying them in a group. I believe that a satisfactory study will result in a great reduction of their generic and specific names. The present names——generic especially—must be considered as only provisional. As matters stand, different names are probably given to the same parasite as it grows on different Lichens. It will be found, moreover, I doubt not, that the number of Lichens of the lower groups (*e. g.* in the single genus *Lecidea*, or its numerous and varied sections or sub-genera) which occur in an athalline parasitic form are more numerous than we at present suppose.

Various members of the group of micro-parasites enumerated in the following list should rather be transferred to the provisional family of *Fungo-lichens*,[3] and may ultimately be claimed as *Fungi* proper. The difficulty of separating the lower Lichens from the lower Fungi is, however, daily becoming greater and greater.[4] The old diagnostic of the

Nylander or other authorities, who regard Lichens as *mere Epiphytes*. I have elsewhere pointed out ("Is Lichen-Growth detrimental to Forest and Fruit Trees?" 'Report of the British Association,' 1867, p. 87) that the *in*organic constituents of the Lichen-thallus prove Lichens to be as *truly parasitic* as are the lower Fungi. The distinction drawn, therefore, by Hallier (pp. 215 and 217) between Lichens and Fungi, as being in the one case "echte epiphyten" and in the other "echte parasiten," is *not* true to nature. Körber designates the group of athalline Micro-lichens here enumerated "Lichenes Parasitici; Pseudo-lichenes, Auct.," and describes them in an appendix. But the designation in question does not apply more properly to this interesting group of microscopic Lichens than it does, *e.g.* to the corticolous species of the genera *Evernia*, *Ramalina*, *Usnea*, *Lecanora*, *Lecidea*, or *Verrucaria*. His group is, moreover, most heterogeneous, for he includes, e.g. *Lecidea resinæ*, Fr., which occurs directly on the bark, as well as its resinous exudates, of various Coniferæ; and which, moreover, is classed among Fungi by Fries, Nylander, and Berkeley.

[1] *Vide* also the author's 'History of British Lichens,' p. 309, and Nylander's 'Synopsis Methodica Lichenum,' p. 58.

[2] Körber (in his 'Parerga Lichenologica,' 1865, p. 452) classes them separately as "Lichenes parasitici;" while they constitute the "Pseudo-lichenes" of Krempelhuber ('Lich. Flora Bayerns,' p. 86) and other authors.

[3] Anzi, in his 'Symbola Lichenum rariorum vel novorum Italiæ superioris,' 1866, enumerates as "inter Lichenes et Fungos ambiguæ" species of the genera *Abrothallus*, *Conida*, *Phacopsis*, *Celidium*, *Arthonia*, *Xenosphæria*, *Phæospora*, and *Tichothecium*.

[4] *Vide* the author's paper on *Arthonia melaspermella*, 'Journ. Linn. Society,' Botany, v. ix; and 'N. Z. Lich. and Fungi,' Trans. Royal Society of Edin., vol. xxiv, pp. 423, 434.

blue reaction with iodine has long since been proved fallacious, inasmuch as, while it is absent in many true Lichens, it is present in many true Fungi. Professor Karsten[1] describes a beautiful violet colour as developed in the stylospores of some *Sphæriæ* by a dilute solution of iodine, and he refers to this as the first known example of a *starch*-reaction in the *stylospores* or *spores* of Fungi. A similar reaction occurs, however, in the filamentous excrescences of some species of *Erysiphe* (Tul.), in the tissues of the fruit of *Septoria ulmi* (Mohl), and in the mycelium of *Polystigma rubrum* and *P. fulvum* (Bary). Currey[2] describes the same starch-reaction in the spores of *Amylospora tremelloides*. Nylander points out in various papers[3] how impossible it is to draw any sharp boundary-line between Lichens and Fungi. The hymenium in Fungi is generally *yellow* with iodine, just as it is (or some of its elements are) under the same reagent occasionally in true Lichens. In *Hysterium elatinum*, Fr., as in the Lichen-genus *Graphis*, the hymenial gelatine[4] is not coloured by iodine, but the *spores* become *blue*. In like manner, *Hysterium Prostii*, Dub. cannot be distinguished from the Lichen-genus *Opegrapha*. In some true Lichens (e. g. *Parmelia ambigua*) the hymenial gelatine is either not coloured or obscurely coloured by iodine. Professor de Bary, a first-rate authority on the anatomy and physiology of Fungi, regards *gonidia* as the only means of distinguishing Lichens from Fungi (Ascomycetes).[5] Inasmuch, therefore, as the parasite-genera *Abrothallus, Celidium, Scutula, Phacopsis,* and *Sphinctrina,* do not possess gonidia, he would arrange them with *Fungi:* as did Montagne,[6] a Cryptogamist who was equally at home among Lichens and Fungi. Such a distinction would enable Lichenologists to appropriate certain plants hitherto considered Fungi, such as *Agyrium*

[1] "On the Peculiarities of some Stylospores of *Sphæriæ*," 'Botanische Untersuchungen,' 1866; or translated by Dallas in 'Annals of Nat. History,' vol. xix, 1867, p. 356. *Vide* also 'Quarterly Journal of Science,' July, 1867, p. 392. If, however, Karsten is correctly translated by Dallas, I am not led to place much confidence in his accuracy of observation or judiciousness of inference.

[2] 'Quart. Journal of Science,' July, 1867, p. 392. *Vide* also author's paper on *Arth. melaspermella*, p. 284.

[3] "On Distinction between Lichens and Fungi," 'Flora,' 1864, pp. 421 and 558. "Ad Historiam reactionis Iodi apud Lichenes et Fungos Notula," 'Flora,' 1865.

[4] *Vide* author's paper on *Arth. melaspermella*, p. 283.

[5] "On the Morphology and Physiology of Lichens and Fungi," in Hoffmeister's 'Handbuch der Physiologischen Botanik,' 1866, p. 271.

[6] 'Ann. des Sciences Nat.,' vol. xvi, 3rd ser., p. 78.

rufum, Fr.,[1] which Nylander[2] describes as a true Lichen, having not only an amylaceous hymenium, but gonidia underneath the apothecium. But the same awkward and artificial distinction would *ex*clude from the Lichens all *a*thalline—and consquently *a*-gonidic—forms, possessed, nevertheless, of all the other attributes of true Lichens. Moreover, it would appear that gonidia are not peculiar to Lichens, as contradistinguished from Fungi, for Gasparini[3] regards *Penicillium glaucum* as a gonidic form of *Alternaria*. My own opinion is that there is *no* boundary-line in nature between Lichens and Fungi, and that all attempts, therefore, of Lichenologists or Fungologists—of Botanists or Chemists—to discover any scientific means of differential diagnosis must prove futile. I hold that the position in classification of doubtful plants must be the result of a compromise or agreement between Lichenologists and Fungologists.

The somewhat long list of micro-parasites after recorded illustrates well the tendency of Naturalists of the present day to distinguish what are presumed to be new forms or conditions of life by separate names, whether generic, specific, or varietal. There is too much of what the Germans call expressively "species-spielerei"—playing at species—a sort of pseudo-scientific recreation that Haeckel[4] compares to the amusement of collecting postage-stamps, or similar trifling—the recreation of so-called Herbarium or Parlour-botanists, who have had generally the most limited opportunities of observation, or whose minds are only able to apprehend minutiæ, and cannot grasp generalities. Such Botanists are characterised in modern phraseology as "splitters," in contradistinction to "lumpers" or "clumpers;" the former delighting in the multiplication of minute divisions and of names, the latter reducing both the divisions and technical terms. It is unfortunate that grounds should exist for such a distinction of fellow-workers in all departments of science; but that it *does* exist, and that the elaborators predominate largely over the generalisers, there can be no doubt. Lichenologists are too much mere nomenclators rather than Biologists—mere systematists—mere searchers for or labellers of forms that are "rare" or "new"—given to the discernment of minute differences rather than of general resemblances—mere collectors of plants and formers of herbaria. Their

[1] *Vide* author's paper on *Arth. melaspermella*, p. 277.
[2] 'Flora,' 1864, pp. 421 and 558.
[3] 'Ann. Nat. Hist.,' vol. xviii, 1866, p. 344. *Vide* also author's paper on *Arth. melaspermella*, p. 282.
[4] 'Generelle Morphologie der Organismen,' Berlin, 1866.

greatest ambition is the detection, description, and nomenclature of a "new" species; but only a small proportion of the so-called "new" species, constantly being added to the Lichen-Flora of Britain or the world, is destined to stability; very few indeed of the host of names conferred on supposed "new" genera, species, or varieties, are necessary in science or useful to the student. The *British* student of Lichenology is bewildered by the number of "new species" that are being daily added even to the *British* Lichen-Flora, while as yet there is no simple and philosophical arrangement of the common forms that are already well known. It would be wrong to depreciate the labours—the enthusiasm and perseverance—of the searchers for and discoverers of "new species:" but it is quite permissible to express strongly the opinion that I cannot place their labours in the same category with those of the Biologists, who, working in great measure, nevertheless, with the materials of the species-hunters, reduce such discoveries to their proper place in a simple systematic arrangement: who study plants in all phases of growth, and who are thus led and enabled to enlarge the definitions of groups, to diminish names, and to simplify classification on natural principles.

I rejoice to find that the views on botanical classification and nomenclature which I have long been led to entertain are substantially those which are held and published by some of the most eminent Naturalists of the present day—by those, to wit, whose experience has been the greatest and most varied. Professor Agassiz, for instance, in his recent work on Brazil, asserts that "the discovery of a *new species* . . . . is now almost the *lowest kind* of scientific work"! Mr. Bentham, the present distinguished President of the Linnean Socity, commends "subjects of inquiry much more important than differences in external form" to "Naturalists residing in countries where no new forms are to be discovered."[1] Dr. Müller, the learned Director of the Botanical Garden of Melbourne, remarks that, "through want of extensive field studies, untenable limits are assigned to a vast number of *supposed specific forms*;" and that "the vain attempt to draw lines of specific demarcation between mere *varieties* or *races* . . . . has largely tended to suggest the theory of transmutation."[2]

The subjoined list does not profess to be complete. It is intended only as a contribution to the subject to which it

[1] Presidential Address, 'Journal of Linnean Society,' "Zoology," No. 42, 1868, pp. lxx, xcv, xcix.

[2] 'Vegetation of the Chatham Islands.'

refers: its aim being to invite or incite other Lichenologists to make similar contributions, in order, in course of time, to the compilation of as full a list as is attainable. It represents only the information to which I have access in my own library. There are so many labourers in the Lichenological field in all parts of the Continent, and, indeed, now in all parts of the world—observers who are constantly publishing their results in multitudinous forms that are unknown or inaccessible to me—that completeness in such a list as mine is unattainable. It refers exclusively to Lichens whose names or descriptions have been already recorded—for the most part by Continental authors. The micro-parasites met with by myself—many of which are, so far as I can ascertain, new, and which require accompanying plates for the elucidation of their structure—are reserved for publication in another paper.

The present list relates to the *lower* Lichens, most of them athalline. Some of the *higher* Lichens are also, however, occasionally parasitic on other species, *e.g.* I have met with various *Parmeliæ* or *Physciæ* parasitic on other *Parmeliæ* or on *Umbilicaria*, in alpine or arctic countries. But there is no difficulty in their determination; and a consideration of *them* does *not*, therefore, form part of the object of the present paper. Of an intermediate character between the parasitic *Parmeliæ* in question and the parasitic *Lecideæ* and other Lichens, presently to be enumerated, are the following:

1. *Ephebe pubescens*, Fr.—On the protothallus of *Stereocaulon tomentosum* and *S. condensatum* (Körb., Syst., 11 and 14).

E. byssoides (Carrington, Irish Crypt., p. 7) creeps over *Hepaticæ*, e.g. *Frullania tamarisci*, v. *microphylla*.

2. *Normandina Jungermanniæ*, Dél. Mudd., 268.

Syn. *Lenormandia*, Dél. Hepp, 476; Nyl., exs. 89.
Verrucaria pulchella, Borr.
Endocarpon, Hook. Leight.
Coccocarpia, Bab.

On various *Hepaticæ*, especially species of *Frullania*, *Radula*, and *Jungermannia*, e.g. *J. dilatata* (Hepp, 476), *F. tamarisci* (Carrington, Irish Crypt., 7); on certain mosses, e.g. *Hypnum cupressiforme* (Nyl., Prod., 174); on various saxicolous *Scytonemata* (Nyl.); as well as on several Lichens, e.g. *Pannaria triptophylla* and *P. plumbea*.

The spores described by Leighton (Brit. Angioc. Lich., 13, and Nylander, Prod., 173) probably belong to a parasitic *Fungus* = *Sphæria Borreri*, Tul., 128 (Körb., Syst., 101).

The *Normandina* itself is, by some observers, regarded merely as the young thallus of a *Pannaria*, e. g. *P. plumbea* or *rubiginosa* (Tul. and Körb.), or *Parmelia*, e. g. *P. perlata* (Schær).

Acharius referred this Lichen to the genus *Thelephora* (*Fungi*).

3. *Lecanora cerina*, Ach.—Parasitic occasionally on dead Lichens, as well as on mosses, wood, &c., in Spitzbergen (*fide* Th. Fries, L. Spitsb., 25).

4. *L. vitellina*, Ach.—Also parasitic on dead Lichens, as well as on mosses, stones, ground, fabricated wood, and other materials, (*e. g.* weathered vertebræ of reindeer), in Spitzbergen (*fide* Th. Fries, L. Spitsb., 19).

5. *L. subfusca*, Ach., and *Urceolaria scruposa*, Ach., are sometimes athalline, their apothecia being grafted, as it were, on the thallus of other species. But Nylander draws a questionable or unnecessary distinction between such cases as these, which are accidentally and exceptionally parasitic (Syn., 58), and Micro-lichens, which are regularly and normally so.

The athalline form of *U. scruposa* is (pr. p. at least) = *Stictis lichenicola*, Mont. (*fide* Nyl., Prod., 96), which, according to Berkeley (Brit. Fungology, p. 375), is a *Fungus* parasitic on the thallus of various foliaceous *Cladoniæ*.

Genus I.—Lecidea, *Ach.*

Under this head systematists have classed a very heterogeneous group of Lichens, differing both in the colour of the apothecia and in the form, colour, and size of the spores. Several have the characters of the true *Lecideæ* as they are defined by modern systematists, *e. g.* Th. Fries or Mudd; that is, they have simple, colourless spores and black apothecia. In others the spores are 2- or more-locular; varying much in length and breadth; coloured or colourless. Several belong to the sub-genus *Buellia*, one to *Raphiospora*, and one to *Biatora*. No rigid classification is necessary, nor is it scientific, for *e. g.* the spores of *L. vernalis*, which are usually simple, are sometimes, in the athalline forms, 2-locular; while apothecia that are usually brown sometimes assume a black hue, and spores that are generally colourless acquire a yellow, olive, or brown tint with age. Besides, it is no part of our present object to arrange according to any scheme of classification the very different, and too frequently anomalous, Lichens which occur in the athalline state occasionally or always. Our knowledge of them is not yet sufficiently

complete to warrant us in making any such attempt. Additions are daily being made to their number, and the relation they bear to the structures on which they grow is becoming better understood. All that is at present aimed at is to arrange them in a group under the most recent names given them by systematists; so that, by exhibiting the confusion which exists regarding their place in classification, some inducement may be held forth to study them more carefully than hitherto.

The parasites at present classed under *Lecidea* may be conveniently grouped according to the character of the spores as follows:

A. Spores usually simple and colourless.

Species 1. *Lecidea vitellinaria*, Nyl.

Synonyms. *Lecidella*, Körb., Parerga, p. 459; Leight., Exs., No. 182.

Lecidea Pitensis, Lönnr.

On thallus of *Lecanora vitellina*, both saxicolous and terricolous forms (Nyl., Prod., 126; Mudd, 212; Th. Fries, Arct., 222). Spores 8, ellipsoid or subspherical. Nylander suggests that it may be regarded as an athalline form of *Lecidea parasema*, an opinion in which I quite concur.

2. *L. inquinans*, Tul., Mém., 117. Nyl., Syn., 179; Lindsay, Monograph of Abrothallus, 6.

Syn. *Abrothallus*, Tul.

Nesolechia, Körb.

Lecidea argillacea, Körb., Syst., 255, Parerg. 462; which, however, is described as usually having a thallus, and when athalline as occurring on that of *Verrucaria epigæa*, Ach.

L. parasitica, pr. p. Tul., 117, the spores of which at once separate it.

On the sterile thallus of *Bæomyces rufus* and *B. roseus* (Nyl., Prod., 145; Syn., 179); or of *Lecidea decolorans* (Tul., 117).

Spores 4–8, ellipsoid or oblong. Tulasne says he has in vain searched for pycnidia. Nylander (Prod., 145) places this Lichen and *Abrothallus oxysporus* in his section *Epithallia* of the genus *Lecidea*, and in his 'Enumération générale' (127) he includes *L. oxysporella*; while Stizenberger ('Beitrag zur Flechten-systematik,' 162) apparently arranges under *Epithallia* the genera *Phacopsis* and *Nesolechia*. It is, at least, most arbitrary and unscientific to place Lichens so closely allied as *L. inquinans*, *L. oxyspora* and *L. oxysporella* in separate genera or subgenera!

3. *L oxysporella*, Nyl., Prod., 145.

On thallus of *Cladonia digitata*.

Spores as in *Abrothallus oxysporus* (*q. v.*), but smaller.

4. *L. associata*, Th. Fries, Lich. Spitsberg., 42.

On thallus of *Lecanora tartarea*. Spores 8, ellipsoid or subspherical. "Ad *fungos* facile rejicienda," says Fries.

5. *L. Cetraricola*, Lindsay (Observations on Greenland Lichens).

On thallus of *Cetraria Islandica*, Braemar, Scotland; and Dovrefjeldt, Norway.

Spores very small, ellipsoid.

6. *L. vernalis*, Ach. (Nyl., Scand., 201), on dead *Peltideæ*.

Apothecia reddish; spores sometimes in this athalline form are obscurely 2-locular, oblong.

7. *L. episema*, Nyl., Prod., 125.

On thallus of *Lecanora calcarea* and *Squamaria saxicola*.

Spores sometimes 2—4-locular, ellipsoid, or oblong. Nylander suggests that it should perhaps be considered an athalline form of *Lecidea parasema*, whose spores, however, are pretty constantly simple.

B. Spores 2- or more-locular, usually coloured (brown).

8. *L. parasitica*, Flk. (Nyl., Prod., 144).

Syn. *L. inspersa*, Tul., Mém., 118: Leight., Exs., No. 183.
L. lygæa, Hepp.
Biatora, Fw.
Buellia, Flk.
Dactylospora Flörkei, Körb., Syst., 271.
D. inspersa, Mudd.
Leciographa Flörkei, Körb., Par.
Celidium insitivum, Körb., Syst., 217.
Celidiopsis, Körb., Par., 458.

(To be continued.)

On Rhabdopleura, *a* New Form *of* Polyzoa, *from* Deep-Sea Dredging *in* Shetland. By Professor Allman, F.R.S.

With Plate VIII.

I am indebted to the Rev. A. Merle Norman for having placed in my hands for examination some of the products of dredgings recently carried on at various depths in the Shetland seas by Mr. J. Gwyn Jeffreys and himself. Among these by far the most interesting is a Polyzoon obtained from a depth of ninety fathoms. It is not only generically

distinct from all previously known forms, but is in many respects so peculiar as to render it necessary to regard it as the representative of a still more general section of the class.

The following characters will afford generic and specific diagnoses of the new Polyzoon.

RHABDOPLEURA, Allman.

Cœnœcium consisting of a branched, adherent, membranous tube, in whose walls, along their adherent side, a rigid chitinous rod extends, and whose branches terminate each in a free open tube, through which the *Polypides* emerge.

Lophophore hippocrepial, with a shield-like process on the hæmal side of the tentacular series; *Polypides* connected to the chitinous rod by a flexible cord or funiculus.

Name.—Ῥαβδος, rod, and πλευρον, side, in allusion to the rod-like structure which is developed in the walls of the cœnœcium.

Rhabdopleura Normani, Allman. Pl. VIII.

Cœnœcium sub-alternately branched; *ectocyst* delicate, transparent, and colourless: free portion of the cœnœcial tubes of the same diameter as the adherent portion, and very distinctly and regularly annulated.

Habitat. Creeping over the surface of dead shells from a depth of ninety fathoms.

Locality. Shetland seas, J. Gwyn Jeffreys, Esq., and Rev. A. Merle Norman.

The remarkable polyzoon for which the genus Rhabdopleura has been constituted is eminently distinguished by the presence within its cœnœcium of a rigid chitinous rod (blastophore) (fig. 1 *d, d, d*). This rod runs along the adherent side of the cœnœcium, but is not found in the free prolongations of the branches through which the polypides move in the acts of exsertion and retraction. The rod contains an axile channel, which is very evident in the younger parts of the cœnœcium, where it may be seen to be filled with a granular pulp (fig. 9), but in the older parts the channel appears to have become nearly or even quite obliterated.

At the points where the rod gives attachment to the funiculus or cord, by which the polypides are connected to it, a slight enlargement of its diameter forms a sort of platform for the attachment of the cord, and at these points a very thin transverse septum would appear to be stretched across the tube, which thus becomes divided into a series of separate chambers, one appropriated to each polypide. The

septum, however, cannot always be demonstrated, and, in some cases at least, appears to be incomplete.

Most of the polypides are attached laterally to the rod by means of their funiculus, but ultimately the rod ends by giving support to a terminal polypide similarly attached to it.

The tubes *a*, *a*, *a*, from which the polypides emerge, are of the same diameter as that of the rest of the cœnœcium, of which, indeed, they are simple continuations. At their commencement they are adherent like the other portions, but they soon become free, and then ascend, more or less vertically, from the surface of attachment. They are beautifully annulated, the annulation being due to circular ridges, into which the outer surface of the ectocyst is raised, and which follow one another at short intervals, and with perfect regularity. The inner surface of the tube is quite smooth. The annulated condition may occasionally be traced for a little distance backwards on the adherent portion, while the rest of the adherent portion exhibits, under proper illumination, a peculiar marking in the form of slightly elevated and very faintly marked ridges (fig. 4), which are seen upon the upper side of the tube, and whih here take an oblique course from the margins towards the centre, till each is interrupted by meeting the corresponding ridge from the opposite side.

The whole of the tubular cœnœcium, both the free and the adherent portion, is perfectly hyalline, so that the adherent portion, which has not the distinct annulation of the free tubes to assist in rendering it visible, is liable to be overlooked under too low a power and with insufficient illumination. Under such circumstances the polyzoon presents an anomalous appearance, the dark opaque central rod, with its appended polypides and the free annulated tube being the only parts visible.

The polypides are hippocrepian. They are, indeed, as completely so as in *Plumatella* or any other typical hippocrepian polyzoon. My specimens, however, being such only as had been for several months immersed in strong spirits, do not allow me to speak with certainty as to the existence of the calyciform membrane which connects the bases of the tentacles in all the other known typical hippocrepians. Neither can I say whether an epistome—another striking and important feature in all hitherto known hippocrepian Polyzoa—is or is not present in Rhabdopleura. These and some other points of structure must remain undetermined until the examination of living specimens shall afford an opportunity of seeing the soft parts in an unaltered condition, and of witnessing the natural evolution of the poly-

pide and the display of its organs, in a way which no needle of the anatomist can ever be expected to imitate.

A feature, however, of great interest in the structure of the polypide of RHABDOPLEURA was very satisfactorily made out from my specimens. This consists in a remarkable shield-like organ (fig. 2 *b*), which is borne on the convex edge of the body of the lophophore. It lies outside of the tentacular crown, the hæmal side of which it covers and conceals, at least in the contracted state in which the polypides necessarily existed in my specimens. It is of a somewhat pyramidal form, and might be taken for a very large and peculiarly developed epistome, were it not that its position, lying as it does to the hæmal side of the mouth instead of lying between the mouth and anus, as well as the phenomena of development to be presently described, oppose themselves to this view of its homologies.

It may be that the continuity of the tentacular series is interrupted at the base of the shield. The parts, however, are at this spot so completely hidden by the shield that an examination of living specimens will be necessary, in order to enable us to say with certainty whether this be really the case, or whether the tentacles pass uninterruptedly round the lophophore, as in other hippocrepian forms. In either case the shield lies entirely outside of the tentacular series. As in other hippocrepians, no gizzard is here developed in the alimentary tract.

From the anal side of the alimentary canal at some distance above the fundus of the stomach, a flexible cord, the "funiculus" (fig. 1 *c*, *c*, *c*, fig. 2 *d*, *d*), passes backwards until it reaches the rod to which it then becomes attached. The flexibility of the funiculus contrasts with the rigidity of the rod; and during life it must have freely yielded to the motions of the polypide in the acts of exsertion and retraction. Indeed, its extensibility must be very great in order to allow of the exsertion of the polypide from the extremity of the tube. It is accompanied by a long fasciculus of muscular fibres (fig. 2 *d'*), which is attached to the chitinous rod at the point which gives attachment to the funiculus; and at the point where this is attached to the body of the polypide it divides into two bands, one passing along the right side, and the other along the left side of the body, to be attached, each at its own side, to the pharynx below the lophophore. These fibres constitute the great retractive muscles of the polypide.

But besides conducting the retractor muscles to their point of attachment to the rod, the funiculus usually presents a series of dilatations. A greater or less number of

these appear subsequently to coalesce, and ultimately form a single large oval or somewhat reniform body, which clothes itself in a firm, dark brown, chitinous capsule, and, after the disappearance of the polypide, remains behind in the tube (fig. 1, *e*, *e*, and fig. 3). I regard it as a statoblast. The formation of statoblasts in RHABDOPLEURA would thus correspond in most points to what we know of their formation in *Plumatellæ*, *Alcyonella*, and other freshwater phylactocœmatous polyzoa where they are also developed in the substance of the funiculus. The statoblasts of RHABDOPLEURA, however, differ from the corresponding bodies in the freshwater genera by being less definite in form and size. Their contents consist of clear spherical bodies resembling cells, but destitute of distinct nucleus. My specimens afford no evidence of any portion of the animal specially devoted to the formation of ova or of spermatozoa.

By the aid of acetic acid it was possible, in some of the younger parts of the cænæcium, to separate the endocyst from the investing ectocyst as a very delicate membrane; only faint indications were obtained of that portion of it which, during the retracted state of the polypide, becomes reflected over the tentacles, so as to form the tentacular sheath.

In some parts of the cœnœcium the polypides may be seen in various stages of maturity, and an opportunity has been thus afforded to me of determining some important points in the development of the bud.

In a very early state (fig. 5) the bud may be seen as a minute, flattened, somewhat rhomboidal body, attached by a short thick peduncle, the rudimental funiculus, to a little process of the rod similar to that which gives attachment to the funiculus of the adult polypide. In a slightly more advanced stage (fig. 6) the bud has somewhat increased in size, and there may be now seen, projecting from its distal edge, two short, cylindrical, tentacula-like processes (*b*). Careful examination now renders it evident that the greater part of the bud is enclosed between two fleshy plates (*a*) united to one another in a part of their circumference, and free in the remainder. It is from between the two plates, where their edges remain disunited, that the two tentacular processes project. These processes are the two arms of the crescentric lophophore, showing, as yet, however, no trace of tentacles.

In a more advanced stage (fig. 7) all the parts have still further increased in size, the arms of the lophophore (*b*) project to a greater distance from between the edges of the right and left valve-like plates, and each carries a double series of minute hemispherical tubercles; these are the rudiments of the ten-

tacles. The two plates may now be compared to the covers of a book attached to one another along the back, but having the remainder of their edges free. They are composed of elongated prismatic cells. While the arms of the lophophore project from between their distal free edges, the fundus of the stomach (*c*) with the attached funiculus (*d*) may be seen projecting from between the proximal edges. The funiculus is still short and thick.

As development proceeds the lophophore (fig. 8, *b*) becomes greatly increased in size, and the minute tubercles of the previous stage now show themselves as unmistakable tentacles. The whole of the body, however, with the exception of the projecting arms of the lophophore, and the cul-de-sac of the stomach with the funiculus, is still enclosed between the two valve-like plates which have hitherto kept pace with the general enlargment of the bud.

In the further progress of the development the plates cease to keep pace with the growth of the other parts, and by the time the polypide has attained its full size and adult form they cover but a small portion of the whole, and may now be seen as the peculiar shield-like organ (fig. 2, *b*) which performs so important a part in the morphology of RHABDOPLEURA.

In thus following the development of RHABDOPLEURA it is impossible not to be struck with the resemblance of the valve-like fleshy plates to the mantle of a lamellibranchiate mollusc, whose lobes lie, as here, to the right and left of the body, instead of being placed dorsally and ventrally, as in the *Brachiopoda*. The conviction is thus forced upon us that the right and left plates of the young RHABDOPLEURA may, after all, be the representatives of the mantle-lobes of a Lamellibranch.

If this be so, a new light is thereby thrown upon the morphology of the *Polyzoa*, whose relations must then be admitted to be more intimate with the *Lamellibranchiata* than with the *Brachiopoda*, with which the *Polyzoa* have of late years been associated. Indeed, the most important difference between a Polyzoon and a Lamellibranch will be found in the direction of the intestine, which, instead of finally bending[1] towards the closed or dorsal edge of the mantle, retains its original neural flexure, and runs at once towards the open or ventral edge. The absence of a heart and specialised respiratory apparatus is of comparatively slight importance, and, like the degraded condition of the nervous system, only shows the low stage of development on which the *Polyzoa* rest.

[1] See Huxley, article "Mollusca," in 'English Cyclopædia,' and "Lectures on Comparative Anatomy."

Further, the two arms of the lophophore will represent the labial tentacles of a Lamellibranch; and since that portion of the endocyst which forms the tentacular sheath in the retracted state of the polypide is apparently continuous with the posterior edge of the mantle, there can be no difficulty in finding, in the cœnœcium of a Polyzoon the representative of the siphon of a Lamellibranch.

It should also be noticed that the whole polypide of Rhabdopleura is remarkably compressed from side to side, a fact which further bears out the views here maintained of its relations—views, however, which are in no way inconsistent with the obvious relations of the *Polyzoa* to the *Tunicala*.

The following diagrammatic figures will facilitate a comprehension of the relations here attempted to be proved between a Polyzoon and a Lamellibranch.

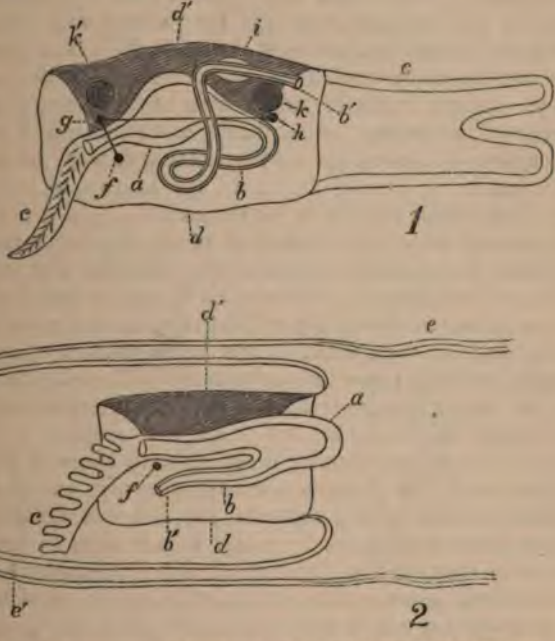


FIG. 1.—Diagrammatic Section of a Lamellibranchiate Mollusc.

a, stomach; *b*, intestine; *b'* anus; *c*, labial pulp; *d*, ventral edge of mantle; *d'* dorsal edge of mantle; *e*, siphon; *f*, pedal ganglion; *g*, cephalic ganglion; *h*, parietal splanchnic ganglion; *i*, heart; *k*, posterior retractor muscle; *k'* anterior retractor muscle.

FIG. 2.—Diagrammatic Section of a Bud of *Rhabdopleura*.

a, stomach; *b*, intestine; *b'*, anus; *c*, lophophore; *d*, ventral or open edge of mantle; *d'* dorsal or closed edge of mantle; *e*, cœnœcium; *e'* reflected portion of endocyst forming tentacular sheath.

Note *on a* Point *in the* Habits *of the* Diatomaceæ *and* Desmidiaceæ. By Arthur Mead Edwards.

(From the 'Proceedings of the Boston Society of Natural History,' vol. xi.)

Although most writers on the subject are in the habit of stating that many of the genera of Diatomaceæ in the living state are free, or non-adherent to other larger algæ or submerged substances, yet always since I first began the study of the Protophytes, as is well known to my fellow-students with whom I have from time to time discussed the subject, I have held that all species are, at some period of their existence, in an adherent or attached condition, growing upon, for the most part, aquatic vegetation of a larger size. I have also frequently expressed the opinion that the adherent condition of any species was but temporary and conditional; otherwise I could not see how the wide distribution of forms, such as *Cocconeis scutellum*, an extremely widely diffused marine species usually found attached to larger algæ, or *Tabellaria flocculosa*, an equally cosmopolitan fresh-water species found almost invariably attached, was provided for, as no motile spores of any kind are known to exist in this family, although such may be the case.

At the outset of my studies of these extremely interesting organisms I naturally accepted the classification laid before me by the authorities on the subject, and referred the forms I found to one or the other of the divisions of free or attached genera, and, in fact, went so far as to construct and adopt terms expressing these two conditions. The adherent forms I grouped under the general head of Epiphytaceæ and the free under that of Eleutheraceæ. As my studies progressed, however, I was continually meeting with cases in which this arbitrary mode of division would not apply, and the natural conclusion come to was that the method was defective, as it did not agree with facts. At last I have thus to publish my conviction that such a division of the Diatomaceæ into free and attached genera does not exist in nature, and that most if not all species are free at one period of their existence and attached at another. I have seen several species which are almost universally ranked as fixed species existing in a natural state free and possessed of motion which they never displayed in their attached condition. Although it is not my intention at the present time to go very deeply into this subject, yet I desire to record that I have noted the following instances of such occurrences among others of a similar kind.

Gomphonema acuminatum and a *Cocconema*, the species of which was not at the time determined, moved about in a vigorous manner when found naturally detached, and also when freed from their stipes by violence. Again, several years ago I made a gathering of *Schizonema cruciger*, a species which consists of siliceous frustules enclosed within tubes of membranous material growing upon other submerged matter, having its frustules free and swimming actively about upon the surface of the water without any signs of investing tubes, which, however, were found empty but standing erect and adherent at the bottom of the ditch inhabited by the *Schizonema*. I have noticed that bare stipes of an *Achnanthes*, without any pendent frustules, are by no means uncommon, and also *Gomphonema* stipes can be found in the same condition. In such cases, doubtless, the freed frustules might be found near by, and, in fact, I have in what may be called "free" gatherings, floating upon the surface of the water, observed *Cocconeis*, *Achnanthes*, and other forms which at one time I was in the habit of classifying as Epiphytaceæ. Once I freed by violence *Schizonema Grevillei* and a *Synedra* which accompanied it, and they both moved about in a rather lively manner, although the motion of the *Schizonema* was much more vigorous than that of the *Synedra*. This was not remarkable, as the frustules of *Schizonema* and *Homœocladia* are well known to be freely movable within their investing tubes, although I do not remember to have seen the fact of their activity without that enclosure recorded. The observance of these facts of the motion of the detached frustules of such well-known forms as *Schizonema*, *Gomphonema* and *Achnanthes*, calls up in the mind the question of the individuality of the Diatomaceous frustule, and it is a point to which I would call the attention of students as one deserving and, in fact, calling for further and searching investigation. If the whole frond of a *Homœocladia* with its myriads of enclosed frustules is an individual, then is the usually free *Nitzschia*, a single frustule of which cannot be morphologically distinguished from a single detached frustule of *Homœocladia*, also an individual?—and is a *Navicula* an individual as well as the group of similar forms enclosed within the tube of a *Schizonema* or the gelatinous frond of a *Mastogloia?* Again, is a *Cyclotella* an individual as well as the long chain of discs which go to make up the frond of a *Melosira* or *Podosira?* Upon this point I shall, hereafter, have more to say, merely begging the record of an observed fact bearing thereon by students of this extremely interesting and, I am convinced, important branch of natural history.

I desire to place on record that I have seen at least two apparently and generally acknowledged free species of Desmidiaceæ attached to a submerged aquatic moss. One was, *Closterium*, species not determined, which was for a long time (as during the most of last summer the specimens were growing in one of my aquaria) attached pretty firmly, by means of a true stipes or stalk of no great length, to the leaves of the moss, and that so strongly that it required some considerable force to detach it. By rocking the covering glass upon the slide, upon which the specimen of moss was placed during observation by means of the microscope, the *Closterium* could be made to swing about from side to side upon its stipes without becoming detached. The other species, observed at the same time, was a *Micrasterias*, and this was fixed, generally in pairs, to the same moss, by its broadest side, or by both valves, so as to present a "front view" (as it is termed when speaking of Diatomaceæ) to the observer, thus presenting an analogy to the genus *Epithemia* of that family which occurs growing after the same manner; *Cocconeis*, on the contrary, is attached by means of the whole of one of the valves. The stipes of the *Closterium* was, of course, at the end of the frustule where the valve comes to a point, after the manner of a *Cocconema*, which genus *Closterium* resembles much in form. In neither of these cases do I designate the species, as that I deem hardly of importance, the mere fact of Desmidiaceæ being found under such conditions being the important one. At the same time it is as well to mention that these species were thus found during the month of August, or in the midst of the summer, the same forms having been observed free and movable in the early part of the spring.

I have now to place upon record my opinion that the Desmidiaceæ are governed by very much the same law as applies to their apparently near allies the Diatomaceæ; that is to say, that they are all at some period of their existence attached, and at another free.

On Naked Fresh-Water Radiolaria. By Dr. Gustav Woldemer Focke, of Bremen.[1]

The distribution of animals in the older strata of the earth's crust would lead one to assume that fresh-water lakes could not have been inhabited until a late period, and, indeed, the distribution of living beings in fresh and salt waters is now very disproportionate. With regard to many orders of the animal kingdom, nature seems to have made some feeble attempts to populate fresh waters, and then to have given up the matter; with others the distribution in both quarters is tolerably equal, although no very important physiological differences seem to exist; with the majority the sea presents a most decided predominance. Until recently Radiolaria have been found only in the sea, or at least shell-less free-living forms have never yet been observed in fresh water. In the middle of last summer I, to my great surprise, discovered at the same source three different kinds of creatures which presented decided characters of Radiolaria. As most of the inhabitants of the sea belonging to this order are enclosed in hard porous shells, the examination of their tissue elements is rendered difficult to a great degree; consequently, the opportunity of examining these free-living forms from fresh water offer a very desirable facility for making a minute investigation.

Unfortunately the information which can be supplied concerning these creatures is as yet extremely fragmentary. Of the history of their development no particulars can be given. The present report, therefore, will merely indicate the existence of shell-less fresh-water Radiolaria, in order to give some notion of the facts relating to them, and to attract the attention of any other observer, since the systematic determination and the physiological description of these creatures cannot be attempted with any prospect of success until more minute investigations have been made. The creatures have a restricted range of locality, and in that range are probably quite as scarce, since numerous organisms, some of which are smaller, existing together with them, have been recognised for a long time, and minutely described. The locality in which fresh-water Radiolaria have been found is moor-pools, that is to say, places in peat moors into which flow streams from neighbouring sandy parts or old waste downs; into these is discharged a scanty stream of water, which remains

[1] Dr. Focke is evidently unaware of the researches of Mr. Archer, of Dublin, on this subject, who has already in this Journal characterised one, at least, of Dr. Focke's genera. See "Dublin Club Minutes."

at an almost constant temperature of 8° R. by day, and is never dried up. The fauna of these moor-pools, with regard to the character of the creatures inhabiting them, the number of the species they contain, and the rarity of these species, varies very much from time to time; this is probably due partly to differences in the quantity of water in the stream, and partly to some mixture of it with rain water or water from some other source. Desmidiaceæ and Diatomaceæ were also observed; the number of forms was small, some of the species being rare, but the variety of specimens not very remarkable. At different periods of the year the predominant species inhabiting these pools are replaced by others. With regard to the Radiolaria, nothing has yet been determined on this point, since from the time of their discovery attention has been almost exclusively devoted to the new and particular forms brought under notice during three months of summer.

The first sign of Radiolaria was presented in a small glass vessel filled with moor water, one side of which, turned towards the light, presented a bright-green lining, formed by numerous Desmidiaceæ. Whilst searching amongst the green globules, discs, fronds, &c., for fitting specimens, I met with a small green round body, which appeared to be surrounded by a layer of jelly-like material. After this had been removed with a pipette, and placed upon an object-bearer, I found that it was a globular body indicating *Pandiorna morum* or some allied form. On repeated examination I discovered that there was a great difference between the impression that had been made by the object first presented and that of the round body in the field of the microscope; the conviction was consequently forced upon me either that I had not removed the proper body with the pipette, or that its character had been altered during the transmission. Whilst endeavouring to clear up this obscurity by employing a stronger magnifying power, I was called away. On my return I was not a little surprised at the change that had occurred. A covering of delicate sarcode had developed itself as a broad border around the globular body, from which numerous extremely fine, long, and pointed processes now passed outwards in a radiating direction. By peculiar to-and-fro movements which accompanied the elongation and retraction of these processes, slow and irregular locomotion, apparently working in one fixed direction, was produced. This, then, was a discovery of a previously unrecognised animalcule, which, indeed, at first sight seemed to bear some affinity to the Rhizopoda, and, in particular, to the Actinophrys, but

which was, as the following description will show, a shell-less fresh-water member of the Radiolaria.

The most careful investigation was at first attended with but little gain; nevertheless, the mass of sarcode presented at first one, and afterwards several, green globules, which varied somewhat in size; as the number of these globules was constantly two, four, eight, or sixteen, processes of division so frequently observed in similar instances were indicated. In these creatures could be recognised a dark double contour of integument, which enclosed the green globules; within this was discovered a mass of nuclei, which at one part, namely at that lying close to the inner surface of the membrane, appeared of a green colour, and at other parts was colourless; this presented a very dark contour, refracted the light strongly, and varied somewhat in extent. About the green globules was next presented a broader border of sarcode — that delicate, extremely fine, and ever-moving substance which consists sometimes of mucous elements, sometimes of very fine, tortuous, and intercrossing lines, with granules scattered here and there between them. From this layer of sarcode start up pyramidal tongue-shaped processes, and very fine spiny threads composed of the same substance, and always placed at right angles to the tangents of the spherical body, from which they radiate in all directions. As these long processes end in extremely fine points, and are constantly extended and retracted, thus probably causing the movements of the whole mass, their actual limits may be the better determined the smaller the magnifying power employed, since with powerful objectives their points are removed too rapidly from the adapted focus. The pyramidal tongue-shaped processes without doubt take part in these movements, since they can be seen to arise and disappear; their movements, however, seem to be slower, but cannot be satisfactorily investigated in consequence of the general commotion.

The different parts of such an organism, so far as they can be optically determined, might, then, be reckoned from within outwards as follows:

1. The centre of the sphere is filled by colourless plasma strewn with granules varying in size, which in itself, or in consequence of the presence of the very broadly and darkly contoured granules, refracts the light strongly on, or appears brighter than, the surrounding water. This contrast is presented most distinctly before the focus is closely adapted, and when the details cannot yet be recognised with precision.

2. In the outer portion—that lying close to the including membrane—of the plasma which is strewn with colourless

granules, exist largish, green-coloured corpuscles, and here and there, in the midst of these, dark specks; these green corpuscles are scattered very irregularly, and often slowly change their positions. They vary somewhat in size, being on the average about $\frac{1}{800}'''$ in diameter. I counted about one hundred of these in one body.

The spherical body sometimes presents in its interior a bright and sharply defined gap; this, which will be again referred to, appears like a *vacuole*.

3. The border of plasma enclosing the granules forms a compact membrane, clear as water, and showing a broad contour, which is darker and more sharply defined externally, and appears, in the majority of instances, to be the covering of the sphere. Examples are not wanting which prove that this membrane is very extensible, and capable of being projected externally at several parts of its circumference. This membrane, however, should not be regarded merely as an enveloping structure to include the contents of the body from the surrounding media, and to prevent changes in its form, since in the marine Radiolaria it is concerned in the formation of the shell. In the fresh-water forms the membrane is sometimes roughened, and, presenting, as it were, a transition stage in the process of incrustation, is elevated at the base of each sarcode process into a swollen protuberance, which projects in the form of a half-sphere, and carries upon its summit the process. Both protuberances and sarcode processes are often provided with chitinous sheaths, which remain unaltered after death. The extraordinary delicacy of the enveloping membrane admits of no chemical examination; the slightest touch, and even the dropping of distilled or rain water of a different temperature, causes the whole of it to coagulate into a shapeless mass.

4. The outer layer of sarcode, whilst contracted, is so transparent and delicate that it will often fail to supply an optical impression of its existence or extent. When visible, it appears as a symmetrical covering closely surrounding the central capsule, and with the same light-refracting power; thus at the most the contours of the envelope are somewhat widened, but to what extent it is difficult to estimate with the spherical form, as a change is induced by the slight displacement of the focus. When any part of the outer layer of sarcode gradually becomes visible, a faint shadow is formed about the lining membrane for a distance corresponding to that of the indistinct contour, which is rendered clear only by rapid movement of the light. With regard to the optical peculiarities of this layer of sarcode, nothing more

can be indicated; and much labour and trouble, and the employment of all accessory means at command, supply one merely with the fact that there is something present, without being capable in the slightest degree of denoting what its characters may be. In this sarcode are presented light and dark spots, delicate, tortuous threads, very small granules, and now and then a larger vesicle, indicating a limit by faintly shadowed lines which always disappear instantly when looked at closely. These threads, granules, &c., always keep at some distance from the outer border line, so that a still brighter margin surrounds the transparent inner mass. In some instances the outer limit of this margin was found curled and plicated; it is a question, however, whether these individuals which presented this condition were in a state of perfect vitality.

From this layer of sarcode, which at the most can be distinguished only as a faint clouding around the enveloping membrane, now arise processes which, by virtue of their prismatic or cylindrically conical forms, can be better discerned. At times they are found completely retracted; afterwards, some make their appearance at different parts of the circumference, and one can generally declare, so long as the lining membrane of the capsule is preserved, or remains not essentially altered, that these processes extend in a radiating direction, and are placed at right angles to the tangents of the spherical body. The most frequent form is that of a long needle with a very fine tip, which always remains straight even when the needle itself is slightly curved at its lower part. Among these needle-shaped processes exist, in several Radiolaria, flattened and lancet-shaped prolongations, which do not extend to so great a length, and which, like the former, take the direction of the radii of the spherical body. These, however, are distributed more sparingly over the surface, and are never projected simultaneously with the needle-shaped processes. When, during a long sojourn under the microscope, a complete unfolding at all parts of the sarcode layer has taken place, these tongue-shaped processes may be seen distributed with moderate symmetry, and appear in number to bear a proportion to the finer and longer processes of one to four or five. Nothing more precise can as yet be supplied with regard to these processes; and as during their full unfolding the movement becomes more active, and a rapid change of place continues to be associated with a more frequent rising and sinking in the water, it becomes extremely difficult, with the frequent change of focus and the concern about retaining the object

in the field of the microscope, to state precisely whether this or that process stands in the same row, or is placed above or below the other.

The fundamental form of the fresh-water Radiolaria seems to be the sphere, but this does not, however, preserve the stability which, in the majority of Rhizopods, is dependent upon the shell, nor does it present that rapid, proteus-like change of form shown by the Amœbæ, &c. The spherical contour may, indeed, be converted into an oval or becomes a triangular one, with very rounded angles, when external influences are not opposed. When the determined direction of the creature's movements is obstructed the whole body flows in an irregular and elongated form about the obstructing object, and seeks the nearest passage; next follows an irregular, unsymmetrical distribution of the sarcode processes on its surface. These changes in form take place slowly, and the previous condition is slowly regained.

To the clear, sharply defined, and vacuole-like spot occasionally observed within the central capsule the less importance is to be attached, as the specimens which presented this had probably ceased to live.

Neither an accurate determination of the size of these creatures, nor more precise details as to colour can be given. The division processes appear to reduce the diameter of the central capsule. No measure of full-grown specimens can as yet be given, and the variable form of the body stands in the way of this. The size of the species described in this report fluctuates between $\frac{1}{30}'''$—$\frac{1}{45}'''$. The colour appears only darker or lighter, with changes in the illumination; the relation, however, between the coloured and transparent granules in the sarcode undergoes change, and the coloration consequently acquires an altered character. The observed tints of green and red correspond more to the colours of the Infusoria than to those of chlorophyll and the red Algæ. With regard to the sarcode no further information can as yet be given in addition to that already dealt with by other observers in good works on the Rhizopoda, &c. The hitherto obscured divergence of the processes in a radiating direction hardly permits the notion that a fusion of any of these processes generally takes place, and such has not yet been made out during processes of division. Very frequently the most flattened processes are filled with plasma-corpuscles.

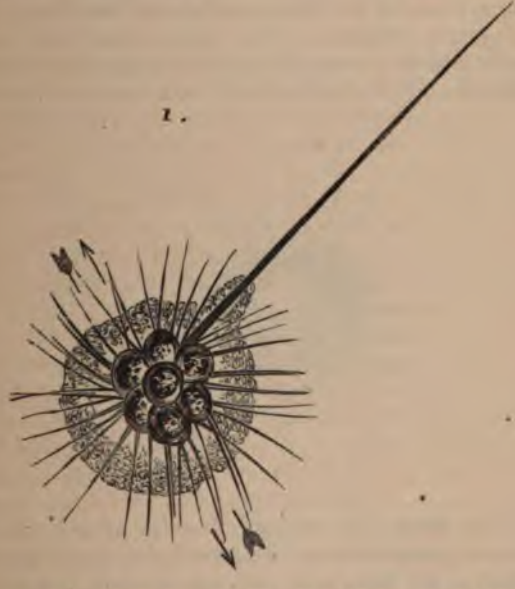
The fresh-water Radiolaria cannot be easily confounded with allied Rhizopoda, and as the first glance finds something so characteristic, they cannot be considered as Desmidiaceæ. Actinophrys is very similar in form, but possesses a con-

tractile vesicle, and never retracts its processes, which, again, are always less numerous. Any confusion, however, will always be prevented by observance of the rapid movements in one direction which these Radiolaria present.

By far the greater part of the marine Radiolaria bears a hard trellised shell and firm spines, spiculæ, hooks, &c. The fresh-water Radiolaria being shell-less and unprotected, their structure is consequently more simple, and they will therefore fall into a place in systematic arrangements before the more protected marine Radiolaria—according to Häckel's system, before Thalassicola—and thus extend the ranks of the Radiolaria.

Dr. Focke gives full details concerning these species of shell-less fresh-water Radiolaria, and refers the reader to appended illustrative plates.

No. 1.—The first species presented at first sight four green globules, surrounded by a border of sarcode and needle-shaped and tongue-like processes. Division processes were indicated by the fact that these globules were found in other specimens in groups of two, eight, and sixteen. The granules within the



enveloping membrane, particularly those near the periphery of the body, were subjected to rapid movements. In these forms the sarcode layer and processes can scarcely be di

tinguished at the first examination, but become extended after remaining at rest for a time under the microscope. The movement of the bodies is constant, slowly progressive, and apparently in a direction towards the light. The globular bodies formed by processes of division are sometimes separated into two or more groups, each of which retains its own envelope of sarcode. When this has taken place the contours of the globular bodies become very irregular, and the bodies themselves are more widely separated. The whole of the creature is sometimes broken up into a number of isolated bodies, each of which is perfectly round, and furnished with its own layer of sarcode and with processes. Very long fine processes are sometimes thrown out from one body to another and connect the two. These isolated globular bodies also undergo division processes. One of these, with included globules, and furnished with a long process, suspended by which the whole moves backwards and forwards like a pendulum, is represented by fig. 1. Some of the creatures here described undergo the following changes:—The processes are gradually retracted into the sarcode layer, a part of which is then elongated, and presents internally separated particles of the lining membrane enclosing isolated masses of green granules. The lining membrane is sometimes lengthened in a pyriform shape and becomes distended near the small end, and presents there a vacuole-like vesicle.

2.

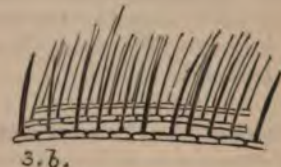
Finally, after death the elongated mass of sarcode breaks down into molecular matter, the enveloping membrane of the capsule retains its dark and distinct contour, the colourless granules are removed, and the green granules withdrawn from their original position near the perpihery.

No. II (fig. 2).—Two forms are described. The first con-

sists of a somewhat smaller body than that of the preceding species. In this the granules lying near the enveloping membrane are coloured red instead of green. The border of sarcode is narrower, and the processes, for the most part, are needle-shaped. The second form is represented by much paler specimens, with coarsely granular contents; these are surrounded by a broad border of sarcode bearing very small processes, and often show a large, bright, and sharply defined circular gap (vacuole?). Whether this form really represents a distinct species remains as yet undecided.

No. III (fig. 3*a*, 3*b*).—This species is represented by green

3.*a*



3.*b*.

bodies, which are supplied with a narrow border of sarcode and a considerable number of needle-shaped processes. They differ from the first species in their size, the absence of tongue-shaped processes, the number and distribution of the needle-shaped processes, and in the increased proportion of green-coloured granules. The form of these creatures is circular, oval, or triangular, with very rounded angles. With a very highly magnifying power a cellular structure may be observed in the enveloping membrane, particularly at its outer surface, where each needle-shaped process is placed on the summit of an elevated cell. The lower part of each long needle-shaped process is often enclosed in a fine sheath (chitine?), which may be recognised after the death and dissection of the creature. This sheath, which is about $\frac{1}{40}'''$ in length and $\frac{1}{800}'''$ in breadth, is inserted into the summit of the swelling on the surface of the lining membrane. (This is illustrated by an ideal figure at 3*b*.)

In conclusion, Dr. Focke states that he has reasons for believing that *Eremosphaera viridis* belongs properly to the Radiolaria. This organism, which presents a large green globular body, and multiplies by twofold division, was first considered to be a germ-corpuscle, and afterwards one of the Algæ.

NOTES AND CORRESPONDENCE.

Our esteemed correspondent Count Castracane requests us to correct two expressions in the translation of his paper on the "Reproduction of the Diatomaceæ" in the last number. In page 258, line 24 from the top, for "vessel" read "cell;" and in page 259, line 22, instead of "inclosed in" read "enclosing."

Adulteration of Tobacco with Starch.—The Government have been recently carrying on prosecutions against tobacco manufacturers and dealers for having in their possession tobacco adulterated with starch. Amongst the numerous adulterations to which tobacco is exposed it was not till very recently suspected that starch was ever employed. Of course, such an adulteration, if suspected, could be easily detected by the aid of the microscope. This arises from the fact that the mature leaf of the tobacco—the part that is used in commerce—possesses no perceptible traces of starch. It is true that during the early stages of the growth of the tobacco traces of exceedingly minute granules—which are true starch-granules—can be detected. These, however, are very different from the starch detected by the Government officers in the tobacco seized in the prosecutions alluded to. In all the cases the starch was either wheat- or rice-starch. In some cases the starch had been boiled before application had been made of it to the tobacco leaf, but this did not interfere with its ready detection under the microscope, by the aid of its reaction with iodine. The quantity varied from 2 to 7 per cent. This quantity is very small; but, practically, it is found that tobacco smeared with starch will take up more water, and thus the tobacco is made to weigh more by the addition of starch. The starch in these cases, however, has not been added so much with the object of increasing the weight of the tobacco as to enable the manufacturers to improve the workable properties of the tobacco. In all cases this adulteration was found in the Irish roll tobacco, and it is in the manufacture of this

article that the flour of the cereal plants was found of advantage. Great praise is due to the Inland Revenue for carrying out this prosecution so successfully, and thereby protecting the honest trader. These prosecutions could scarcely have been carried on but by the aid of the microscope. It was through the energy and intelligence possessed by Mr. Philips, the superintendent of the Inland Revenue Laboratory at Somerset House, that this instrument was placed in the hands of the revenue officers under his guidance; and this is not the first instance of extensive frauds having been detected by its agency.—E. L.

Coccoliths and Coccospheres. By G. C. Wallich. September 7th, 1868.—In a lecture "On a Piece of Chalk," delivered by Prof. Huxley to working men during the recent meeting of the British Association, and published with the author's initials in the September number of 'Macmillan's Magazine,' attention is directed to certain minute bodies, to which he gave the name of "coccoliths," as met with in soundings obtained in 1857 by Capt. Dagman in H.M.S. "Cyclops." Speaking of these bodies, the author says, "Dr. Wallich verified my observation, and added the interesting discovery that not unfrequently bodies similar to these coccoliths were aggregated together into spheroids, which he termed coccospheres." He goes on to say that "A few years ago Mr. Sorby, in making a careful examination of the chalk, by means of sections and otherwise, observed, as Ehrenberg had done before him, that much of the granular basis possesses a definite form. Comparing these formed particles with those in the Atlantic soundings, *he* found the two to be identical, and thus proved that the chalk, like the soundings, contains these mysterious coccoliths and coccospheres."

In the above extract I will, with your permission, point out one or two inaccuracies, no doubt unintentional, on Prof. Huxley's part, but of sufficient importance to induce me to beg you will afford me the opportunity of correcting them, and at the same time of drawing the attention of naturalists to some additional facts connected with the bodies in question.

The occurrence of the spheroidal objects to which I assigned the name of coccospheres, as being most intimately connected with the coccoliths of Prof. Huxley, was detected by me in North Atlantic soundings, whilst on the surveying cruise of H.M.S. "Bulldog," in July, 1860, a general notice of their existence having appeared in my 'Notes on the presence of Animal Life at great Depths in the Sea' in November of the same year, and a detailed description, with figures

and measurements, having been published by me in the 'Ann. & Mag. Nat. Hist.' in July, 1851. The identification of the coccoliths of the soundings with those of the chalk (to the last of which attention was drawn by Ehrtenberg and Mr. Sorby) was announced for the first time in the two papers just referred to, Mr. Sorby's paper having appeared in the 'Annals' in September, 1861. In this paper Mr. Sorby actually refers to the spheroidal bodies under the name I gave them. The merit of the identification spoken of by Prof. Huxley, such as it is, I have therefore a right to claim as mine.

The coccoliths, however, cannot correctly be said to be "aggregated together into the spheroids," as stated in the lecture. They are in reality arranged, at intervals, over the surface of the spheroidal cell, on which their concave surfaces rest, and which is, to this extent, a separate portion of the structure. When detached, as they invariably appear to be in the chalk and the fossil earths (of which I shall have occasion to say a word presently), they bear the same relation to the supporting cell that the fallen fruit bears to the tree that bore it, and nothing more.

Of their true position in the organic world I am ignorant. But I have these important facts to add (referred toby me incidentally in a paper on "The Polycystina," which was read before the Royal Microscopical Society in May, 1865, and published in the 'Transactions' of that Society), that I have detected coccoliths in abundance, and retaining their normal characters, in some of the fossil siliceous earths of Barbadoes, &c., and that coccospheres have been met with by me profusely in a living, or perhaps it would be more safe to say a recent, condition, in material collected at the surface of the open seas of the tropics, and also in dredgings from shoal water obtained off the south coast of England.

It only remains for me to add that, so far as the chemical nature of these bodies can be ascertained by reagents and the polariscope, there is reason to believe that carbonate of lime enters largely into their composition; and they furnish us with another striking example, in which simplicity of structure has enabled an organism to weather the vicissitudes to which the surface of the globe has been subject, and under the operation of which more complex forms have ceased to exist.—*Athenæum* for Sept. 19, 1868.

Prof. Huxley, at Mr. Sorby's request, replied to this letter and defended Mr. Sorby's claim. See also his paper in the last number of this Journal.

Nachet's and other Immersion Lenses. — A correspondent wishes for the opinion of the readers of the Journal on the comparative merits of immersion and other lenses, for various forms of work. We shall be happy to insert any remarks upon the subject, based on experience.

Cell Diagnosis.—We are anxious to suggest to those who have the time the importance of a series of observations on the various forms of tissue, the hairs, pollen-grains, raphides, and starch-granules of plants. Any observer who will carefully examine a genus at a time, in these respects, as Mr. Gulliver has done quâ Raphides, would perform valuable work. We should be pleased to publish a series of such papers.

Palu.—Some time ago a very small quantity of a fine silky substance was brought to England from California under the above name, and it was used as an object for the microscope, on account of its beautiful structure. Mr. Bingham, in his very interesting paper on the "Volcanic Phenomena of the Hawaiian Islands," says—"*Palu* is the silky covering of the opening fronds of several species of tree ferns, and is exported in large quantities to California, for beds, &c." (p. 426). The trade is so extensive that "corduroy roads" are made to the station where it is collected, and whole districts are leased for the "*Palu* business," and there is a large number of "*Palu*-pickers." The *Palu* is collected at Kelauéa, which is the most tropical region in Hawaiia; the tree ferns have stems fifteen feet high to the base of the frond, and eight or twelve inches in diameter.

REVIEWS.

One Thousand Objects for the Microscope. By M. C. Cooke. *With* 500 *figures.* London: Warne and Co.

Mr. Cooke is so well known to the scientific world as an active and careful observer with the microscope, that any work from his pen would be sure to be welcome. In this little book he has done a really excellent service to the young microscopic observer. At the present day, many persons possess microscopes who have no one near them to point out the many objects of interest around them on which to employ the microscope. Mr. Cooke here comes forward as their guide; and by the aid of 500 very cleverly executed engravings displays the variety of objects for microscopic research, which may be collected from the vegetable and animal kingdoms. As Mr. Cooke has not classified the objects, it would be impossible for us to give anything like an idea of their nature or variety. It will suffice for us to say that he gives illustrations and descriptions of minute animals and plants, also of the minute anatomy of both; and of the parts, such as hairs and scales; and the secretions, such as starch, of the various members of both animal and vegetable kingdoms. The work is dedicated to the members of the Quekett Club, of which Mr. Cooke was one of the founders. He offers it as the gift of a father to his children; and we are sure his hope will be realized,—"that it may be bread and not a stone."

The Record of Zoological Literature, 1867. *Volume Fourth.* Van Voorst.

Another volume of this exceedingly valuable work has appeared; and an arrangement has been suggested by the able editor, Dr. Albert Günther, and acted upon by the publisher, which enables those interested in a special de-

partment of zoology to purchase a part of the 'Record' containing that which relates to their subject, without having to pay for the whole. The vertebrates form one part; the insects, spiders, and myriopods another; and the rest of the invertebrates, a third. It is this last volume which will be of most interest to our readers, containing as it does the literature relating to the minuter forms of animal life. Dr. Edouard von Martens has given account of the papers and separate works relating to the class Mollusca, and to the great group of Crustacea, which appeared during the year 1867; whilst Professor Perceval Wright, of Trinity College, Dublin, has done the same for the Molluscoida, Rotifera, Annelida, Scolecida, Echinodermata, Cœlenterata and Protozoa. The study of all these groups is intimately associated with the microscope; and it is pleasant to see the pages of this Journal not unfrequently referred to in the 'Record.' No fitter recorder than Dr. Wright could have been found for the work, which he has done with the same ability as in former years. We could, however, wish one thing; and that is, that space would permit the recorders to give a short account of many of the papers which now are merely entered by their titles. Though, in our own chronicle, we attempt to keep a record of the current literature relating to microscopic organisms, it is yet not possible for us to obtain the same survey as the yearly recorder; and in his pages will be found references to some works and papers on microzoological subjects which have not come under our notice: besides this, many of those who work with the microscope are doubtless interested in special branches of zoology; and to those the Zoological Record will be invaluable. As a matter of duty, those who wish for the progress of zoological science in this country, and who can afford it, as we trust many can, should prove their regard for science by the purchase of the 'Zoological Record.'

QUARTERLY CHRONICLE OF MICROSCOPICAL SCIENCE.

Histology. NERVE.—Researches on the Intimate Structure of the Brain. Second series. By Lockhart Clarke. 7 plates. *Philosoph. Trans. Roy. Soc.*, 1st part, 1868.

Studies on the Structure of the Cortical Substance of the Human Brain, Part II. By Rudolf Arndt. 2 plates, 15 pages. *Max Schultze's Archiv*, 1868, 4th part.

Changes in the Nervous System which follow the Amputation of Limbs. By Dr. Dickenson. *Journal of Anatomy*, No. III, p. 88, pl. iv.

Nerve-corpuscles of the Penis and Clitoris in Mammalia and Birds. By W. Bense. *Henle u. Pfeufer's Zeitsch.*, xxiii, p. 1.

End-apparatus of certain Nerves. By Ludwig Letzerich. 1 plate. *Virchow's Archiv*, part 4, 1868. 1 plate.

Mode of Termination of Nerves in the Testicle. By L. Letzerich. *Virchow's Archiv*, March, 1868.—The author states that the nerve-fibres pierce the membrana propria of the tubuli seminiferi, and end in a more or less irregular pyramidal mass of protoplasm, in which lie clear elliptic nuclei. The ends of the fibres lie, therefore, in close relation to the outer layer of secreting cells.—*Journal of Anatomy*, November, 1868.

Structure of Nerve-fibres. By Dr. Grandry. *Bull. de l'Acad. Roy. de Belgique*, xxv, p. 304.—From observations made into the structure of nerve-fibres immersed when perfectly fresh into solution of nitrate of silver, Dr. Grandry concludes that the axial cylinder is composed of two substances of different physical and chemical properties, which present a regular disposition. It probably consists of trans-

versely arranged discs, separated from each other by a substance which possesses different properties from the discs themselves. A resemblance, therefore, may be traced between its structure and that of striped muscle. He concludes, also, that two different substances exist within the nerve-cell which appear to possess, as in the axial cylinder, a disc-like arrangement.—*Journal of Anatomy*, November, 1868.

Reply to W. Krause on the Membrana Fenestrata of the Retina. By Hensen. 4 pages. *Max Schultze's Archiv*, 1868, 3rd part.

Muscle.—Structure of Striped Muscular Tissue. By W. Krause. *Henle u. Pfeufer's Zeitsch.* 4th Part. 1868.

Contributions to the Knowledge of the Smooth Muscle-fibres. By Dr. Schwalbe. 1 plate, 17 pages. *Schultze's Archiv*, 1868. 4th Part.

The Ciliary Muscle in Fish, Birds and Quadrupeds. By R. J. Lee. *Journal of Anatomy*, No. III, p. 14.

On the Ciliary Muscle of Domestic Mammalia. By Dr. Flemming. 2 plates, 22 pages. *Max Schultze's Archiv*, 1868, 4th part.—Consult in connection with this F. E. Schulze's paper in No. IV, 1867, of the same Archiv.

Blood, Lymph, and Vessels.—The so-called Amœboid Movements, and Cohnheim's Inflammation phenomena. By Dr. Dönitz. *Reich. u. Reymond's Archiv*, 3rd part. 1868.

The Exudation of Blood-cells, &c. By W. Koster. *Nederlandsch Archief voor Genees- en Natur-kunde*, III, 3rd part, 1868.—W. Koster's paper affords an exemplification, in addition to others already given in this series, of the close alliance existing between physiology and pathology. It consists chiefly of illustrations, drawn from pathology, of the fact originally observed by Cohnheim, of Berlin, that, "By a simple and easily repeated experiment with the mesentery of a frog, we can satisfy ourselves that in the commencement of an inflammatory process, while the red blood-cells are still carried along with great rapidity through the axis of the vessel, the colourless blood-cells remain firmly adherent to the inner surface of the minute veins and capillary vessels. We speedily see, particularly in the minute veins, the colourless blood-cells penetrate *into* and soon *through* the wall, and gradually diffuse themselves in the intervening tissue. At the same time they, now and then, like Amœbæ, alter their form, acquire one or more pointed outrunners; in a word, distinctly manifest their

contractility." From the foregoing the following corollaries are deducible :—The analogy between pus-cells and colourless blood-cells; the impossibility of distinguishing the two in the blood; the morphological agreement between a recent exudation (as in pneumonia or pleuritis) and the product of purulent softening of the same, on microscopical examination, &c.—*Journal of Anatomy*, November, 1868.

New Experiments on the Genesis of Leucocytes. By Dr. Onimus. *Robin's Journal*, November and December, 1868.

On Capillary Vascular Systems in the Gasteropoda. By Professor C. Wedl. *Anzeige der Akad. der Wiss. in Wien*, July 23rd, 1868, p. 179.—The theory proposed by Milne-Edwards, that in the Mollusca the arterial and venous systems are not united by a capillary system, but that a system of lacunæ destitute of proper walls intervenes between them, is not confirmed in the Gasteropoda investigated by the author. In *Helix*, *Limax*, *Turbo*, *Limnæus*, and *Murex* he has ascertained the existence of closed capillary systems, with proper walls and characteristic of the different organs; these may be displayed by injection either from the arterial or the venous side. The existence of a lacunar system must be denied even in the respiratory organs. Nor could he convince himself that the vascular system is open either towards the cavity of the body or the outer surface. Hence the theory of the imperfect circulation of the blood in the Gasteropoda is, at least, not of universal application.

These observations of Professor Wedl's are of greater importance when considered in connection with Mr. Charles Robertson's recent account of a similar condition of things in *Helix pomatia*. Mr. Robertson's observations are reported by him at p. 148 of Vol. VII of our Journal.

On the Lymphatic Vessels in the Tail of the Young of Batrachia. By C. Langer. *Anzeige der Akad. der Wiss. in Wien*, July 23, 1868. Successful injections of this system of vessels facilitated the detection of many uninjected vessels, which could be traced from the ends of the injected portions of the tubes for a long distance in the tissue of the border of the tail. They not only permitted the arrangement of the whole system, but also the structure, connection and termination of the individual vessels to be investigated.

The author found that they have sharply marked, even outlines, without any indentations. Their appearance, as regards the constitution of the walls and the form of the nuclei, was hardly different from that of the fine blood-

vessels. The limitation of the capillary lymphatic ducts by proper walls is easily ascertained in this object.

The capillary lymphatic vessels form a network, which in the smaller tadpoles, and in the fine border of the tail in larger ones, is diffused only in a single layer, but is overlaid on both sides with the network of blood-capillaries.

At the margin of the vascular regions there are capillary lymphatic loops, of which some are remarkably narrowed; but even in the interior of the border, thread-like anastomosing branches are also met with so much narrowed that their complete impermeability seems a matter of course. This supposition is rendered still more probable by the discovery of similar portions attached to injected ducts. In this case they had also in part become coloured, but were only permeated as far as to the narrow part, usually furnished with a nucleus, where the coloration was limited to the form of a pointed narrow stripe.

Cæcal terminations of the lymphatic tubules also occur; these issue broadly from the wall of a capillary, and usually terminate quickly in a point, after producing a nucleus. It is possible that some of these extremities may be only apparently constructed in this manner, and really represent only one arm of a very narrow loop, the continuity of which cannot be traced; but appended portions which run out into a fine point, free on all sides, can hardly be regarded as anything but true cæcal terminations of lateral ramifications.

The signification of these, as also of the very narrow thread-like loops, must be genetic. In favour of this view is their similarity to the corresponding forms of the blood-capillaries, which are regarded and described as tubules in course of development. We must, however, in the author's opinion, know precisely what influence contractility and the treatment of the object may have upon the form of the finest vascular tubes, before we can with certainty regard all these vascular appendages as transition forms of new ducts.

Origin of Minute Lymphatic Vessels. By N. Afonassiew. *Virchow's Archiv*, July, 1868.—N. Afonassiew, by employing the method of physiological injection introduced by his teacher (Chrzonszczewsky), has arrived at the results stated as follows:—The connective-tissue-corpuscles are independent cells, and form, through the union of their processes, a system of anastomosing nutritive canals, from which the finest lymphatic capillaries, possessing independent walls, arise. This view is not in accordance with the opinion entertained by certain anatomists of the Vienna school, who consider that the lymphatics arise from mere spaces in the

connective tissue. Afonassiew has also inquired into the very curious observations made by Recklinghausen, Ludwig, Dybkowsky, and Schweigger-Seidel into the existence of minute pores between the epithelium-cells forming the free surface of the serous membranes, and through which orifices the serous cavities communicate with the lymph-vessels, He regards it as affording origin to them, and as acting like an intermediate system during the process of nutrition between the blood and the lymph.—*Journal of Anatomy*, November, 1868.

Gland.—Structure of the Kidney in Birds. By H. Lindgren.—*Henle u. Pfeufer's Zeitschr.*, xxxiii, p. 15.

Structure of the Kidney (in Bats and Children). By M. Gross. *Robin's Journal.*—M. Gross investigates the structure of the kidney in bats and children by the method of isolating the tubes by the action of hydrochloric acid. The straight tubes of the medulla pass towards the surface of the cortical substance, where they branch; the branches then bend backwards into the medulla, form the looped tubes of Henle, which again pass into the convoluted tubes and capsules of Malpighi.—*Journal of Anatomy*, November, 1868.

The Lorenzinian Ampullæ of the Selachians. By Franz Boll. 1 plate, 17 pages. *Max Schultze's Archiv*, 1868, 4th part.

The Goblet Cells of the Intestinal Mucous Membrane. By Theodore Emier. *Virchow's Archiv*, March, 1868.—Theodore Emier communicates a long article on the goblet cells of the intestinal mucous membrane. He reviews the previously published papers on this subject. He adduces numerous observations and arguments in opposition to Sachs and others, in favour of the view that the goblet cells are definite structures, and not artificial productions. He describes and figures the mouths (stomata) of these cells opening between the free ends of the cylindrical epithelium, and points out that from their deeper ends, as well as from their narrow extremity of the cylindrical cells, processes pass off into the subjacent mucous membrane.—*Journal of Anatomy*, November, 1868.

Goblet Cells and Ciliated Epithelium of Mollusca. By Rabl. Rückhard.—Rabl. Rückhard regards the striated appearance of the intestinal epithelium as due to folds in the cell-membrane. In *Buccinium undatum* he recognises goblet-shaped cells like those described in the vertebrata, situated between the ordinary cylindrical epithelium.—*Journ. of Anat.*, loc. cit.

Tegument.—On the Morphogy of Hairs. By Dr. A.

Goette, of Tubingen. 2 plates. *Max Schultze's Archiv*, 1868, 3rd part.—This is an exceedingly valuable paper of fifty pages in length, in which the whole question is reviewed and discussed in connection with a large series of new observations.

The Mode of Growth of the Bristles of the Chitons. *Kölliker und Sieb. Zeitschr.*, 1868, part 3.

General.—Structure of the Araneidæ. By Drs. Reinhold Bucholz and Leonhard Landois. *Reich. u. Reymond's Archiv*, 2nd part, 1868. 2 plates.

Vegetal.—Outlines of a Comparative Anatomy of Foliaceous Mosses. 9 plates. By P. G. Lorentz. *Pringsheim's Jahrbucher*, 3rd part, 1868.

Researches on the Structure of the Pistil. By M. P. van Tieghem. *Annales des Sciences Naturelles (Botanique)*, ser. 5, vol. ix, p. 127.

Embryology.—Development of the Semilunar Valves. By Dr. Morris Tonge. *Proc. Roy. Soc. London*, April, 1868.

Researches on the Development of Osseous Fish. By C. Kupffer, Professor in Kiel. 3 plates, 64 pages. *Max Schultze's Archiv*, 3rd part.

Researches on the First Rudiments of the Vertebrate Body. By Professor Wilhelm His. *Leipzig, F. Vogel.*—This is a quarto volume of 237 pages, and 12 large plates. It is a most important contribution to the subject.

Development in Ovo of Certain Crustacea. By MM. Edouard van Beneden and E. Bessells. *Bull. Acad. Roy. Belgique*, 1868.—The authors recognise two distinct types of development. In the *first*, which is seen in the marine Amphipods, the Copepods, and certain Lerneæ, there is found in every point of the egg's surface a layer of cells, which is nothing more than the vitelline globules devoid of their nutritive matter. There is total segmentation. In the *second*—as in most Lerneæ—there is a progressive formation of the blastoderm, without total segmentation. The fresh-water Amphipods belong to this group.

Microzoology and Microphytology.—A New Species of Sarcoptidæ of the genus Glyciphaga. By Ch. Robin. *Robin's Journal*, November and December, 1868. 3 plates.

Monograph of the Recent British Ostracoda. By George S. Brady. (Complete.) 19 plates. *Linnæan Transactions*, Part II, 1868.

Bryozoa of the Adriatic. By C. Heller. 6 plates.—*Trans. Zool. Bot. Soc. of Vienna*, xvii.

A Contribution to the Anatomy and Development of the Phylactolæmatous Fresh-water Bryozoa, especially of *Alcyonella fungosa*, Pall., sp. By H. Nitsche. *Reich. und Reymond's Archiv*, part 4, 1868. 4 plates.

Observations on Polyzoa, sub-order Phylactolæmata. With 9 plates. By Alpheus Hyatt. *Proceedings of the Essex Institute*, vols. iv and v, 1866—1868. Salem, Mass., U.S.A.—A very careful and valuable description of the organization of the fresh-water Polyzoa. Many histological details are given, and some remarks on general homologies are offered. We cannot agree to any "necessity" for speaking of the fixed end of a polyzoon as its "anterior," and the free end as its "posterior" extremity. Anterior and posterior in relation to what? If in relation to the activity of the animal, then assuredly the oral extremity must be called—as is usual—"anterior." But "anterior" and "posterior" are bad words to use in homological nomenclature. They then *mean* nothing. Three specimens of Fredericella, four of Plumatella, one Pectinatella, and one Cristatella, are here described. The plates are executed in white on a black ground. Synoptical tables of great precision and detail are given.

Observations on British Zoophytes and Protozoa. By T. Strethill Wright, F.R.S. 1 plate. *Proc. Roy. Phys. Soc. Edinb.*, vol. iii.

On the Anatomy of Gordius. By Dr. H. Grenacher. *Zeitschrift für Wissenschaftliche Zoologie*, September, 1868. —In this contribution is given a full description of the anatomical composition of *Gordius ornatus* taken from the abdomen of a Mantis in the Philippine Islands. The result of Dr. Grenacher's investigations on this specimen, which was a female, and also on specimens of *G. aquaticus* and *G. subbifurcus*, differ from those previously reported by Meisner, particularly with regard to the termination of the intestinal canal and the generative organs. The so-called excretory orifice at the posterior extremity of *G. ornatus* leads into a cloaca, the lining membrane of which is evidently an inward extension of the external integument, as it is covered by short pointed papillæ. This cloacal cavity is surrounded by circular fibres of a muscular character; superiorly, it is continuous with a wide tube which forms the receptaculum seminis. In the front wall of this tube, near the opening of the cloaca, is the slit-like orifice of the intestinal canal. A section through the body of the creature, near its extremity, presents four tubes: two lateral, the oviducts, and two median, the receptaculum seminis and the intestine. The oviducts are somewhat tortuous, and terminate in front in the ovaries, which in this specimen were distended with closely packed polygonal cells. The intestinal canal passes, for a short distance, in front of the

receptaculum seminis, and then passes to one side of it. In specimens of *G. aquaticus* and *G. subbifurcus* the receptaculum seminis was found to contain abundant sperma, and to occupy almost the whole of the section. The internal organs are separated by abundant, perienteric, cellular tissue. In male specimens of *G. aquaticus* and *G. subbifurcus*, Dr. Grenacher found at the extremity of the tail a wide flask-shaped cloaca, placed at right angles to the long axis of the body. At the posterior wall of this were three openings—one, the intestinal orifice, placed superiorly and in the median line, and the remaining two, which formed the external openings of the vasa deferentia, placed inferiorly and on either side.

Dr. Grenacher, in his conclusions concerning the much-disputed point of an oral orifice in these creatures, states that so long as the Gordius is parasitic there is a distinct mouth in direct communication with the intestinal canal; but when the parasite has passed from the body of its host and commences a free life, the mouth is more or less obliterated. Sometimes a trace can be discerned of this opening, sometimes it is altogether absent; the anterior portion of the intestines at the same time undergoes atrophy, and its place is occupied by cellular tissue.

Noctiluca miliaris. By Dr. Dönitz. 1 plate. *Reich. u. Reymond's Archiv*, 2nd part, 1868.

On *Noctiluca milaris*, Sur. By J. Victor Carus. 2 pages. *Max Schultze's Archiv*, 1868, 3rd part.

In No. 2, says Dr. Carus, of the 'Archiv für Anatomie, Physiologie,' &c., by Reichert and Reymond which, although published in May, has only just come into my hands, there is a paper by Dr. W. Dönitz, on Noctiluca. Dr. Dönitz has mentioned on page 145 that he has discovered an inexplicable error in that part of the 'Manual of Zoology' which has been written by me. It is that I have described in the diagnosis of Noctiluca a gelatinous parenchyma, as comparable to the mucous tissue of the higher animals. Thankful as I am to have my errors corrected (for I know my works are no more free from them than those of Dr. Dönitz are), I must, however, repudiate statements such as are made in the remarks of Dr. Dönitz. I say, in page 568 of the 'Manual,' "The 'parenchyma' of the body (of Noctiluca), which shows no contractile bubbles, consists of a homogeneous glutinous substance, through which numbers of numerously ramified fine 'parenchyma strings' reach like a skeleton from the nucleus and the stomach towards the circumference, on which are found small bodies, enlarging towards

the interior, which show the same movement as the granules in the pseudopodia of the Rhizopoda. The fibres become finer and finer towards the surface of the animal, until at last they form a meshwork under the outside skin, which is fastened to the same by a finely granulated, cellular layer." For every one who *wishes* to read I thought this clear enough. The difference between my view and that of Dr. Dönitz is that the substance between the sarcode skeleton (*gerüst*), which I have taken to be organic, he has considered to be salt water. If I have used a term (in the shortly framed diagnosis, which was meant merely to sharply characterise the one group from the other) which suggested a cellular multiplicity, I may, perhaps, be to blame; it cannot be imputed to me, however, in direct contradiction to my unmentioned full description, that I imagined for one instant there could be a parallel drawn between the substance of the Noctiluca and the connective substance of the vertebrate animals.

Dr. Dönitz goes on to say, in page 146, "These cells ['the obviously cellular layer' of the outer skin, as mentioned above by me] are nothing more than the meshes themselves, which, by a superficial examination, could be taken for an epithelial-like layer. To suppose that there are cells here, one would be obliged before all things to prove the presence of a nucleus, which would be exceedingly difficult in this case."

Dr. Dönitz, who has not seen the nuclei, may excuse himself on account of the difficulty. But to attribute to me, who have seen the nuclei, a merely superficial examination, is certainly extraordinary, the more so that he has not given himself the trouble to see if others besides myself have observed the same. But now, in the twelfth number of the 'Zeitschrift v. Wissenschaft. Zoologie,' page 564, there is a paper by W. Engelmann, on the "Cellular Multiplicity of the Noctilucæ," of which Dr. Dönitz should have been aware if he thought necessary to make remarks on this animal. There the nuclei are mentioned, figured, and measured. Seeing that Engelmann and I have come quite independently to the same view of the structure of the Noctiluca, I think that our almost simultaneously published views may be considered as confirming one the other.

On which side is the superficiality, if not of the examination, at least of the critic, I leave the reader to decide.—Leipzig, 15th September.

On Naked Fresh-water Radiolaria. By Dr. Gustav Woldemar Focke, of Bremen. *Zeitschrift für Wissenschaftliche Zoologie*, heft 3, September, 1868. We give this paper elsewhere in full.

Diatoms of Upper Tatra. By J. Schuman. 4 plates (separate). *Zool. Bot. Society of Vienna*, 1867.

Action of Light on Algæ and some Allied Organisms. By A. Famintzin. *Pringsheim's Jahrbucher für wiss. Botanik*, vol. vi, 1st and 2nd part, 1868, p. 1.

Mycological Notes. By F. Hildebrand. 3 plates. *Pringsheim's Jahrbucher*, 3rd part, 1868.

On the Physiological History of the Mucedinæ. By Ph. van Tieghem. *Annales des Sciences Nat.* (*Botan.*), vol. viii, ser. 5.

On the Relations of the Gonidia of Algæ and those of Lichens. *Botan. Zeitung*, 1868.

On the Change of Gonidia of Lichens into Zoospores. By MM. Famintzin and Boranetzky. *Ann. Sci. Nat.* (*Botany*), ser. 5, vol. viii.

Microscopic Diagnosis—The Typical Value of the Lingual Dentition in the right Distribution of the Genera of Gasteropoda into Natural Groups and Families. By John Denis Macdonald, M.D., F.R.S. 1 plate. *Annals of Nat. History*, October, 1868.—This paper will, without doubt, be of interest to many of our readers in whose hands we have recently placed six plates of figures of molluscous odontophores, without, we regret to think, any new or important remarks upon them. Dr. Macdonald's paper will be found to be a really philosophical attempt to advance our knowledge on this subject. It is impossible to abstract a paper which is itself much condensed. As to the value of the lingual ribbon as a microscopic means of diagnosis, Dr. Gray (who has written much on this subject) remarks—

"I think that Dr. Macdonald has committed an error that is common to young naturalists—has mistaken an analogy for an affinity. The form of the lateral teeth of the odontophore is, no doubt, a good specific (and, may be, generic) character; but I think that Dr. Macdonald's table proves that it is not the character of a family. The character of a family should be derived from the consideration of the whole animal—its form, the form and development of the teeth, and the form of the shell and operculum; and not from any one character, such as the form of the lateral lingual teeth, especially if it brings together in the same family such a series of incongruous genera, and separates nearly allied genera as they are separated in Dr. Macdonald's list. Therefore I cannot agree with him that 'the lingual dentition appears to be the only appeal,' or that the best means for arranging the genera and families is according to the form of the lateral teeth. I think, if any one will consult Dr. Macdonald's plate, he must perceive that the

lateral teeth gradually pass from one form to the other; and I cannot conceive any reason why all the forms figured may not belong to the genera of one family."

On the Boring of Certain Annelids. By Dr. McIntosh. 2 plates. *Annals of Natural History*, October, 1868.—Dr. McIntosh shows that a chemical explanation of the means of boring of *Leucodore* is untenable, since that Annelid bores in shale. He figures the bristles of the fifth segment, which differ from those observed by Mr. Ray Lankester in a species of boring *Leucodore*. It is probable that, in this case, "microscopic diagnosis" will prove the existence of two common species of this genus.

Apparatus.—Camera Lucida. *Scientific Opinion*, November, 1868.—A new camera-lucida to be employed in taking sketches of living creatures, such as infusoria, has been constructed by Mr. Charles Collins, optician. The design is by Dr. Colles, of Calcutta. In using the ordinary camera-lucida, or the tint-glass reflector, the body of the instrument must be placed horizontally, or nearly so. Hence, when unmounted preparations in liquid are laid upon the stage they move out of the field of view, or the liquid in which they are placed does so, and no adequate sketch can be made. This difficulty is obviated in the new camera by placing a right-angled tube containing a right-angled prism at its angle, between the body of the microscope and the eye-piece. The stage being then placed in the horizontal position, and the image being thrown upwards, this latter is reflected horizontally by the prism, and is bent up by the tint-glass reflector to the eye. We believe the new camera will be found an extremely useful accessory by the working naturalist.

Manual of Microscopic Photography. By Oscar Reichardt and Carl Sturenburg. *Quandt and Handel, Leipzig*, 1868.—This is an excellent little pamphlet, of some seventy pages, giving the necessary instructions and useful suggestions as to the art of photographing microscopic objects. Four illustrative photographs are given. The first is a cross-section of *Hippuris vulgaris*, and is magnified only $\frac{1}{1}^{2}$. Fig. 2 is a sun-picture of a bit of the tracheæ of the silkworm caterpillar, magnified $\frac{4}{1}^{2}$. Both these photographs are intended to be examined with a lens. The two other figures are portions of *Pleurosigma angulatum*, one enlarged $\frac{3\,6\,0\,0}{1}$, the other $\frac{8\,7\,5\,0}{1}$. The original negatives were taken on collodion-albumen, and Gundlach's glycerine-immersion objective No. 7 was used. A second enlarged picture was then taken. They appear to be satisfactory specimens, though not equalling some of Lieut.-Col. Woodward's. Gundlach, of Berlin, sells a camera

movable on an upright by rack-work, and adapted for fitting over the microscope, which is described and recommended in this little book. The book may be had of Mr. David Nutt, foreign bookseller, Bedford Street, Covent Garden.

Micro-Photography. By M. Jules Girard.—I have recently taken some pictures, the result of powerful enlargements of diatoms varying from 800 to 1200 diameters. To obtain clear objects suitable for enlargement, it is necessary to establish a relation between the lens and the length of the camera; and the more powerful the lens, and longer the camera used, the greater will be this relation. There exists, however, a very variable limit, which is incapable of being passed without altering the sharpness of the object, and which is the result of experimental trials between these two combinations. As the intensity of the light diminishes proportionally to the distance of the object, it is necessary to have recourse to a condenser often composed of several lenses corrected so as to prevent distortion, which gives sufficient illumination to impress the sensitive surface. The focussing must be rigorously exact, as the most inappreciable digression of the microscopic screw is sufficient to injure the sharpness of the object. If enlargements of extraordinary size are required, a process similar to that used for making ordinary photographic enlargements may be employed. A small negative may first be obtained upon a thin strip of glass, which is afterwards magnified by means of the microscope. This method is a very delicate one, and necessitates very careful focussing with a magnifier, in order that the most minute details may be rendered as sharply as possible. In developing there is likewise the difficulty of obtaining a suitable degree of intensity for the object: if the process is pushed too far, the light will be unable to penetrate; if the development is insufficient, the negative will lack clearness. Thus the pictures taken direct possess the double advantage of being easy to produce, and more exact copies of the original.—*A Paper read before the French Photographic Society, extract from 'Scientific Opinion,'* No. 6.

On taking Temperatures in Connection with the Microscope. By Th. Engelmann. 8 pages. *Max Schultze's Archiv,* 3rd part, 1868.

A New Hot-Plate for the Microscope. By Dr. Alexis Schklarewski. 3 pages. *Max Schultze's Archiv,* 1868, 3rd part.

Hæmatoxylin-Colour. By H. Frey.—*Max Schultze's Archiv,* 1868, 3rd part.

PROCEEDINGS OF SOCIETIES.

Dublin Microscopical Club.

16th July, 1868.

Mr. Archer showed fresh specimens of *Chantransia chalybea* and of *Batrachospermum moniliforme*, simultaneously, in order to draw attention to a point of agreement in structure between these Algæ, although of only morphological import; thus, however, tending to confirm the modern view of putting Chantransiaceæ and Batrachospermaceæ side by side in the system. In Batrachospermum, as is well known, the tips of the cells at the summits of the branches are each often produced into a very long filiform appendage, terminating in a somewhat thickened bacillar extremity; in this extremity seem to be condensed the cell-contents, leaving the filiform, stalk-like cell hyaline. Now, in Chantransia quite a similar prolongation of some of the cells terminating the lateral branches is to be seen; they are, however, much fewer, as not by any means every cell is so terminated, nor are they quite so slender, but otherwise they seem to agree with those of Batrachospermum in structure. This character in Chantransia does not seem to be noticed; and whilst Mr. Archer took the opportunity to allude to Hr. Graf zu Solms-Laubach's paper in the 'Botanische Zeitung,' describing the fructification in Batrachospermum, he ventured to suggest that, arguing upon the admitted similarity to some extent in morphological structure, further supported by these filiform processes, we might, perhaps, look out for a similar fructification in Chantransia.

Dr. E. Perceval Wright showed specimens of the spicules of *Steletta nux* (Sel.); also spicules from a new species of Steletta discovered by him at the Seychelles, and described their general points of distinction.

Mr. Crow exhibited a section of Coralline limestone from Honduras.

Dr. John Barker desired to place on record the discovery of *Amœba quadrilineata* (Carter) in this country. It was interesting to note the occurrence of a form not hitherto met with elsewhere than in the tanks of India. This is a minute form, of a broadly pyriform figure, not unlike *A. limax* in general contour and mode of progression, but is readily distinguishable by the

generally four longitudinal lines running down its sides, which lines seem to be due to so many extremely narrow folds or creases; these become, indeed, sometimes obliterated when the animal becomes more than usually broadened out, but they again appear on its reassuming its somewhat pear-shaped figure, and during active progression. It was curious to observe the vigorous flow of the granules down the middle of the body for about two thirds of its length, when they seemed to become suddenly arrested, and quietly lay by to one or other side, thus leaving the anterior one third and a portion of each lateral margin of the animal hyaline; from the anterior margin the very broad and shallow, lobe-like pseudopodia became extended, whilst at the opposite or posterior end occurred the nucleus and vacuole, exactly as described by Carter. As in other forms which agree with this in admitting of an anterior and a posterior end being discriminated, such as *A. limax* and *A. villosa*—the pseudopodia being given off only at one end—the progression of this form was pretty rapid, and executed in tolerably straight lines or slight curves, thus calling to mind the movements of the curious amœboid bodies described by Mr. Archer in *Stephanosphæra pluvialis*, in which instance, however, these consisted of the modified primordial cells of that curious organism. Dr. Barker had had these specimens tolerably abundantly in a gathering, in which they lasted some six weeks, without undergoing any change. Their minuteness and comparative hyaline character rendered them, however, somewhat readily overlooked.

Rev. E. O'Meara showed *Rhizosolenia robusta*.

Mr. Archer showed a really copious gathering of the Polychætus he had brought forward at a previous meeting, and ventured to describe as *Polychætus spinulosus*. A dip from this gathering would sometimes show six or eight of this very elegant rotatorian in one field; in fact, two or three dips would probably disclose more specimens of this form than he had, perhaps, seen altogether before. He regretted the pool (near Carrig mountain) whence these were taken had since dried up, especially as this fine species seems to be rather rare; but still he thought that, if sought for, it must turn up in other similar localities.

August 20*th*, 1868.

Dr. John Barker exhibited a rounded pellucid cyst, enclosing a number of the empty frustules of a Gomphonema, which were quite destitute of contents—in fact, as clean as if prepared by acid. Dr. Barker, with whom Mr. O'Meara seemed to coincide, thought this must represent some phase in the history of the diatom, from which view Mr. Archer was inclined to dissent, conceiving this "cyst" rather to be that of some rhizopodous creature, and its germs discharged, and hence would regard the diatomaceous shells as representing simply the indigestible remains of the animal's last dinner.

Rev. E. O'Meara showed examples of *Amphiprora duplex*, taken at Bray for the first time, after repeated searchings in the locality.

Rev. E. O'Meara, on the part of the Rev. T. G. Stokes, mentioned that the diatom recorded by the latter, in the Minutes of the Club, January, 1866, as *Triceratium Robertsianum*, should, on Greville's own authority, have been recorded as *Triceratium extuberans*.

Mr. Crowe exhibited a copious gathering, from the original Bray-head locality, of *Stephanosphæra pluvialis*, in fine condition and activity, showing that after all we had pilfered away from the very circumscribed little pool in which it occurred, there was still enough left for its perpetuation.

Mr. Crowe also exhibited a section of limestone from Gascony.

Dr. Moore showed specimens of a Stigeoclonium, probably *S. tenue*, which had overgrown and much choked the leaves of *Ouvirandra fenestralis* in the warm house in the Botanic Garden. This plant is very prone to become enveloped by various Confervoids, and it had proved very difficult to grow it at all so as to show the well-known and very remarkable peculiarity of the leaves.

Mr. Archer showed specimens, taken near Arklow, of the Cœlastrum, brought forward by him at the Club meeting, July 18th, 1867, which was gathered on that occasion in Wales, and called by him *Cœlastrum Cambricum*. The present were the first found in Ireland. This form differs from *C. cubicum*, in having one, not three external tubercles to the cells. Some of the present specimens showed young cœnobia formed within the parent cells, and almost ready to make their exit, which is accomplished by the bursting of the inflated wall of the parent cell. In the same gathering occurred numerous specimens of *Scenedesmus obtusus*, also showing young cœnobia within the old cells, and all sizes of young colonies, some escaped, others, as mentioned, still within the expanded parent cell—a state of things which, if it had been seen by those who regard that the colonies increase in number of cells by simple self-division of an original cell longitudinally, and form the well-known double rows by a further oblique division, would have controverted that view, the truth being, as shown by Nägeli, and as the present specimens proved, the young cœnobium is formed by the simultaneous division of the whole contents of the parent cell into the characteristic arrangement proper to the individual form; and the only ultimate change, until new self-division sets in, yet observed, being an increase in size of the constituent cells of the cœnobium.

September 17th, 1868.

Mr. Kirby showed silk from cocoons of *Attacus Cynthia*, or Eria silkworm, which he had succeeded in rearing in the open air, in the neighbourhood of Dublin, during the past year.

Dr. Frazer showed hydrated silica with vegetations of crypto-

gams, their markings produced by gelatinizing silica, and resembling the dendritic appearance of many opaline minerals; but Dr. Frazer believed, from his observations, that the true cause of the latter markings was arborescent forms of red and brown oxide of manganese.

Professor E. Perceval Wright exhibited a specimen of Hyalonema, which he had dredged up from a depth of 480 fathoms, about thirty miles to sea, off the coast of Setubal, near Lisbon. He exhibited the beautiful arrangement of one set of spicula, which form a delicate, open network, covering the otherwise open oscula. He stated that he regarded the siliceous axis as the stem of the sponge mass, called Carteria by his friend, Dr. J. E. Gray, and that he had determined that the end of the axis—as had been suggested by Lovén—where the fibres become loose, is that one imbedded in the mud, the sponge mass crowning the summit, and presenting a somewhat different form in different specimens, though Dr. Wright would here remark that he inclined to believe that almost all the species referable to Wyville Thomson's Order, Vitrea, will be found to be pretty constant in their external forms. From the examination of perfect specimens—now for the first time—will it be possible to determine the exact position in this sponge of all the beautiful spicula figured by Dr. Bowerbank, Max Schultze, and others.

When the sponge mass is washed away or destroyed, then the parasitic Palythoa, which appears to be very common, grows up over that portion of the stem left uncovered by the mud, and presents the appearance figured by Brandt and others. Specimens of this parasite were seen protruding their tentacles, a sufficient answer to the supposition of Bowerbank that they are the oscula of the sponges. Mouths they have certainly, but not at the service of the sponge (Hyalonema).

The Hyalonema would appear to occur at this depth in great quantities; and in addition to the Palythoa, an Adamsia, a Sertularian, and some pretty specimens of a Pollicipes, were all found living, attached to its glassy stem. Professor Wright was greatly indebted to Professor Bocage, of Lisbon, for his assistance in these researches.

Mr. Archer cursorily exhibited a few new or rare forms of Desmidieæ, chiefly Staurastra, taken on an excursion to County Galway, in company with Dr. Barker; as, however, he had not yet had time to examine them with all the critical care requisite, he could only hope to return to them more minutely on another occasion. A few forms in Cosmarium and Staurastrum he thought he must defer till perhaps some time or other he might have an opportunity to compare them with certain Continental forms; two or three he might describe as new on his own authority, whilst two or three more were identical with others occurring nearer home, which he had for some time in his mind's eye as new, but it would be a work of patience and delay to see authentic examples of foreign forms. A few British forms turned upon these gather-

ings which he had never found on the eastern side of this island, and were now exhibited. Amongst these were *Cosmarium ovale* (probably the largest species in the genus), *Cosmarium connatum*, *Cosmarium amœnum*, *Tetrachastrum pinnatifidum*, *Staurastrum gracile*. *Staurastrum Pringsheimii* (Reinsch), and *Micrastrias Jennerie* (Ralfs), both rare here, were likewise exhibited from the Connemara gatherings. One or two other minute types of algæ of seemingly rare or local occurrence likewise presented themselves.

Resolved,—That the Club cannot separate on this their first meeting after the recent Railway Accident at Abergele on the 20th of August last, without expressing their very deep regret at the loss they have sustained by the death of their associate member, the Hon. Judge Berwick. He was a most constant attendant at the Club meetings, and took a very lively interest in the proceedings. His genial presence will not soon be forgotten by the members.

Royal Microscopical Society.

October 14*th*, 1868.

This was the first meeting of the season.

The chair was taken by Mr. James Glaisher, F.R.S., President of the Society.

After some remarks from the President as to the publication of the transactions of the Society, the following papers were read:

"On a new form of Heliostat," by Lieutenant-Colonel Woodward and Dr. Maddox.

"On the Fungiform Papillæ of the Frog's Tongue," by Dr. Maddox.

Some remarks were made by Mr. Henry Lees on Nachet's Binocular, and Mr. Mayall, the photographer, expressed his opinion on the photographs of Nobert's test-plates, made by Lieutenant-Colonel Woodward, and described by him in the Journal for October last. Considerable discussion followed Mr. Mayall's observations.

November 11*th*, 1868.

The President in the Chair.

Professor Asa Gray was elected an Honorary Fellow, and other private business was transacted.

The Secretary announced the donation of a series of eggs of Lepidoptera from Mr. Norman, and a collection of material from the Gulf Stream from Lieutenant Chimno, which was handed over to Major Owen to examine and distribute to the Fellows of the Society.

A paper on the "Venation of Leaves" by Mr. Gorham was

read. It did not relate to any branch of microscopical science. Professor Asa Gray and Dr. Maxwell Masters, who were present, made some remarks from a purely botanical point of view.

Mr. Kent read a paper "On the Branchial Organs of Mysis," in which he described the long filamentous processes of the six pairs of natatory feet of the trunk of this Crustacean as branchial organs, giving as his principal reason that they were in constant motion, and did not present on search any striped muscular tissue, whence the motion was inferred to be involuntary.[1]

Living specimens of *Mysis sp.* from the docks were exhibited.

Mr. Baker of Holborn exhibited a marvellous slide of over 350 diatoms of various genera and species arranged in order in a space of about a quarter of an inch. A slide of ten species of typical test-diatoms was also exhibited. These slides, which appear completely to baffle all explanation of the method in which they have been set up, were prepared by a German manipulator, J. Moeller, of Wedel in Holstein, by whom they are sent to this country for sale. It was resolved to purchase one of the slides of test diatoms.

December 9th, 1868.

The PRESIDENT in the Chair.

Dr. Carpenter exhibited numerous specimens of Foraminifera, &c., obtained during his deep-sea dredging expedition, and made a few remarks thereon. He could not bring before the Society a formal paper for publication, as it was due to the Royal Society, under whose auspices the expedition was fitted out, that that Society should receive the first regular paper on the subject. The expedition was suggested by the extraordinary results that had been obtained in deep-sea dredging off the coast of Norway by Professor Sars, who was Inspector of Fisheries to the Swedish Government, and had therefore all the requisite appliances at his disposal. It was proposed by his friend Professor Wyville Thomson that the Government should be requested, through the Council of the Society, to furnish a vessel for a similar expedition off the British coasts. The request having been made, and liberally complied with, that part of the coast between Scotland (Cape Ross) and the Faroe Islands was fixed upon for operations. The vessel, "The Lightning," with himself and Professor Thomson on board, duly arrived on the ground, but the weather being very unfavorable, operations could not be commenced for several

[1] G. O. Sars, in his 'Histoire Naturelle des Crustacés d'eau douce de Norvége, 1867,' gives a very different account of the branchial organs of *Mysis*, to which we would draw the author's attention. Instead of distinct gills, he states that there are, under the cephalothorax, at the bases of the feet, six peculiar organs, forming flexuous cylindrical tumours of the sides of the body, containing blood, and communicating with the lateral slits of the heart; they are homologous with the branchial vessels of Decapods, but are here peculiarly developed, so as to perform the function of gills. Mr. Kent should also consult Dr. Dohrn's recent paper on Cuma.—E. R. L.

days. A second object of the expedition was to ascertain the temperature of the sea at great depths. For this purpose, they sank three thermometers at each trial, and on account of the uncertainty of registering minimum thermometers, no observation in which at least two of them did not agree was relied upon. They were much astonished to find in one series of observations that at a depth of 500 fathoms the temperature of the sea was only 32° Fahr., for other observers, Sir John Herschel and Dr. Wallich, had given 39° Fahr., as the lowest deep-sea temperature. This cold temperature did not extend beyond a limited area; for on each side of it, and also further westward, the temperature was much higher; and they supposed it to be due to a cold current from the north, meeting here with the Gulf Stream, which latter then passes in a forked direction on each side of the cold area. The range of the surface temperature was from 50° to 54° Fahr., generally about 52° Fahr.

It has long been an interesting question whether animal life existed in the sea beyond a very limited depth. Sir John Ross more than fifty years ago brought up a star-fish from a depth said to be 1000 fathoms, but which was probably 700 or 800 fathoms. It was subsequently stated by the late Professor Forbes that animal life could not exist below 300 fathoms, and his dictum was for a long time generally accepted by the scientific world: but the remarkable results recently obtained by Professor Sars at a depth of 450 fathoms had completely disproved the statements made by Professor Forbes.

Dredging having commenced they came upon a sand bank at a depth of 480 fathoms, where the temperature was 49° Fahr., and which they found contained abundance of Foraminifera. At a depth of 530 fathoms they got a good dredge of Globigerinæ mud, which was found to contain Coccoliths, Coccospheres, new Rhizopods, Molluscs, Crustacea, Crinoids, &c., together with masses of siliceous sponges which when washed had a most beautiful appearance. By another dredge at 650 fathoms they brought up this Globigerinæ mud containing all the varieties of Foraminifera, Crustacea, Sponges, Rhizopods, &c., found in previous dredgings, but not in such great abundance. This is the greatest depth from which such living species have been recovered. The Globigerinæ mud, which they found very widely extended, is of a very viscid character, aad consists of a kind of protoplasmic network in which is imbedded the Globigerinæ, Coccoliths and other calcareous particles. A portion of this mud has been submitted to Professor Huxley, and his examination confirms the view taken of it expressed in his paper in the last number of the 'Quarterly Journal of Microscopal Science.' Their opinion, therefore, is, that given a warm temperature and a gradual subsidence, animal life may exist at any depth. He closed his observations by suggesting that there should be no discussion, as he had brought no paper before the Society, and discussion would no doubt ensue when his paper was read before the Royal Society.

Dr. Wallich requested that there might be a discussion, as he considered that Dr. Carpenter had led the Society to infer that it was Professor Sars who had disproved Forbes' dictum that animal life could not exist below 300 fathoms, and that reflections were thus thrown upon the results obtained by him, Dr. Wallich, in 1860, several years before the observations of Professor Sars, and as there was a correspondence going on between himself and Dr. Carpenter on the subject, he thought the results of other observers ought not at the present time to have been brought forward.

Dr. Carpenter replied that he merely mentioned Professor Sars' observations to show the origin of the present expedition, and he was quite ready to admit that the results of Dr. Wallich were obtained before those of Professor Sars: all that he said was that Professor Sars' observations had completely settled the question of the incorrectness of Professor Forbes' views.

The President remarked that it was understood when Dr. Carpenter consented to come before the Society that there was to be no discussion.

Dr. Carpenter then called attention to the objects exhibited under the Microscopes. These were specimens of Cystellaria, Globigerina, Lituola, Rhabdammina, Testularia, Astrorhiza limicola, Milidine, Cornuspira, Rhizocrinus, Tubes of Pectinaria, Tubes of Annelids, &c. The formation of these tubes is very remarkable. They consist of sand grains or minute shells built up with great regularity and glued together with a ferruginous cement which requires strong nitric acid to dissolve it. In one specimen of Globigerina, the animal itself was to be seen.

A vote of thanks was then passed to Dr. Carpenter for bringing his results before the Society; and also to Mr. Charles Baker, for the loan of six microscopes and lamps wherewith to supplement the Society's instruments in exhibiting the large number of specimens on view.

In accordance with Bye-law No. 18, a Resolution of the Council, which had been read three times before the Society, to remove from the books the names of ten Fellows who were more than two years in arrear with their subscriptions, was balloted for, and there being the requisite majority in favour of the Resolution, their names were removed accordingly.

The President reminded the Society that at the last meeting he announced the presentation to the Society by Lieutenant Chimno of a quantity of mud from deep-sea dredgings, and that Major Owen had undertaken a preliminary investigation of it. Major Owen had now completed that investigation, and the mud having been arranged in eight classes dredged from depths varying from 2000 to 14,000 feet, it was now ready for distribution, and any Fellow desirous of assisting at its complete examination should apply to the Council for that purpose.

Dr. Carpenter called attention to a new description of case for keeping slides, which had been made for him by Mr. Collins. It

was in the form of a book, and so made that a series of trays could be laid upon each other and closed in by a slide at the front. It could then be kept on an ordinary bookshelf.

Quekett Microscopical Club.

(Meeting at University College, London.)

June 26th, 1868. Mr. Arthur E. Durham, F.L.S., President, in the chair.—Mr. J. A. Archer read a paper on "Tobacco," in which the culture of the plant, its manufacture, adulterations, &c., were fully described, aided by numerous diagrams in illustration of its microscopical characters.

The Secretary for Foreign Correspondence announced the communications and donations which had been received from the Continent and United States, and exhibited a slide received from Germany, on which were mounted 400 diatoms, representing 370 species. The names of gentlemen proposed as officers for the ensuing year were read, and notice was given of some alterations in the bye-laws to be submitted at the next meeting.

Thirteen members were elected.

The annual excursion dinner took place on June 23rd. An excursion to Box Hill and the neighbourhood was made during the day, and in the evening forty-four members dined together at Leatherhead, the President occupying the chair.

July 24th, 1868. The President in the chair.—This being the annual general meeting of the club, the report of the committee was read.

The treasurer's report, showing a very satisfactory balance sheet, was read; several alterations in the bye-laws were adopted, and the following gentlemen were elected as officers for the ensuing year:

President.—Mr. Arthur E. Durham. *Vice-Presidents.*—Dr. R. Braithwaite, Mr. M. C. Cooke, Dr. J. M. Dempsey, Mr. F. C. Roper. *Committee.*—Mr. T. W. Burr, Mr. F. W. Gay, Dr. W. J. Gray, Mr. R. T. Lewis, Mr. J. Bockett, Mr. T. Kettering-ham. *Treasurer.*—Mr. Robert Hardwicke. *Hon. Secretary.*—Mr. Witham M. Bywater. *Hon. Secretary for Foreign Correspondence.*—Mr. M. C. Cooke.

The President concluded his year of office by delivering an address, in the course of which he warmly congratulated the members upon the continued success of the club, and upon the highly satisfactory nature of the reports which had been presented.

A cordial vote of thanks to the President was unanimously carried, and his address was ordered to be printed and circulated amongst the members.

Ten members were elected.

Communications from abroad were read, and the proceedings terminated with the usual *conversazione*.

August 25th, 1868. The President in the chair.—Mr. Martinelli read a paper on "Tubules of Crabshell."

Mr. S. J. McIntire called attention to some living specimens of mosquitoes and British gnats, and an interesting discussion followed.

Mr. Brain explained the construction of a patent collecting bottle, which its inventor, Mr. Edward Wright, had presented to the club.

Eight members were elected.

September 25th, 1868. The President in the chair.—Numerous presents were announced.

Mr. Slade read a paper on "The Preparation of Bone and Teeth for Microscopical Examination."

The alleged visitation of mosquitoes, which was discussed at the previous meeting, was again referred to, and some carefully prepared specimens of the lancets, as well as some living insects, were exhibited.

At the conversazione which followed, Möller's type-slide and other interesting objects were exhibited.

Four members were elected.

October 23rd, 1868. The President in the chair.—Amongst the numerous donations 125 slides for the cabinet (contributed by Messrs. Cooke, Russell, Edmunds, and Groves) were announced.

Mr. McIntire read a paper on "Cheyletus."

Mr. T. C. White described a new varnish for microscopical purposes.

Mr. Bockett exhibited a case to contain six live-boxes.

Mr. George described a new form of collecting-bottle.

Mr. Suffolk explained the details of his proposed class for instruction in the use of the microscope.

Mr. Cooke repeated his offer to give a series of demonstrations on microscopic fungi.

Eight members were elected.

November 27th, 1868. The President in the chair.—Mr. Curtis read a paper by Mr. Tatem on "Melicerta."

Mr. Low read a paper "On the Uses and Structure of the Fly's Proboscis."

Mr. Burgess exhibited a new form of collecting-box.

In accordance with notice given in October, the meeting was made "special," and the following addition to the Bye-Laws was adopted, viz., "That any member desirous of compounding for his future subscriptions may do so at any time by payment of the sum of £10, all such sums to be duly invested in such manner as the Committee may direct."

Six new members were elected.

Extra Meetings. *December* 11*th*, 1868.—This evening the first of a series of extra meetings was held in the Library by permission of the Council of University College. The object of these meetings being to afford to members additional opportunities of exhibiting objects and conversing thereon, no business of a formal character was transacted. About seventy members were present, and objects of varied character and interest were placed under the microscopes.

These meetings, which are entirely supplementary to the regular meetings, will be repeated on the second Fridays in the months of January, February, and March, at seven o'clock.

Literary and Philosophical Society of Manchester.

Ordinary Meeting, March 31*st*, 1868.

Edward Schunck, Ph.D., F.R.S., &c. President, in the chair.

"A Search for Solid Bodies in the Atmosphere," by R. Angus Smith, Ph.D., F.R.S., &c.

I have so frequently for many years attempted to find, and have found, organic substances which have passed from the air into liquids in which they were collected, that perhaps the Society will scarcely attend to another attempt, although it indicates, I think, some progress. It was in the year 1847 that I first collected what I believe was matter from the respiration and perspiration, and found that as it was kept it grew into distinct confirmed forms.

Whilst examining some matters relating to the cattle plague I found one or two remarkable points. I had before that time used aspirators to pass the air through liquids, except in the oxidation experiments. At that time I used simply a bottle which contained a little water. The bottle was filled with the air of the place and the water shaken in it. The difference of air was remarkable. A very few repetitions would cause the liquid to be muddy, and the particles found in many places were distinctly organic.

Lately I tried the same plan on a larger scale. A bottle of the capacity of $\frac{4}{1000}$ c.c. was filled with air and shaken with water, The bottle again filled and shaken with the same water, and this was repeated 500 times, nearly equal to $2\frac{1}{2}$ million cbc., or 2495 litres. As this could not be done in a short time, there was considerable variety of weather, but chiefly dry, with a westerly wind. The operation was conducted behind my laboratory, in the neighbourhood of places not very clear, it is true, but from which the wind was blowing to all parts of the town. I did not observe any dust blowing, but if there was dust it was such as we may be called on to breathe. The liquid was clouded, and the unaided eye could perceive that particles, very light, were floating. When examined by a microscope the scene was varied in a very high degree—there was evidently organic life. I thought it

better to carry the whole to Mr. Dancer, and to leave him to do the rest, as my knowledge of microscopic forms is so trifling compared to his. It may, however, interest the Society to hear of a few of these previous attempts, the latest made till recently. I shall, therefore, read from a report to be found in the appendix to that on the cattle plague.

Mr. Crookes also brought me some cotton through which air from an infected place had passed. It was examined at the same time. Taking cotton in the mass, nothing decided was seen; but when it was washed some of the separate films were coated over with small, nearly round bodies, presenting no structure, or at least only feeble traces of it, and perhaps to be called cells. I had not sent gun-cotton, as I intended, to Mr. Crookes, fearing the rules of the post; otherwise there would have been more certainty that the bodies spoken of did not exist previously on the cotton. However, Mr. Dancer, who has examined cotton with the microscope oftener than most persons, even of those experienced in the subject, had never observed a similar appearance.

The liquid had also a number of similar bodies floating in it.

It was then that Mr. Crookes sent a liquid which he had condensed from the air of an infected cowshed, at a space a little above the head of a diseased cow. It was also examined, and it presented similar indications of very numerous small bodies. Not being a professed microscopist, I shall not attempt a description, but add that they clearly belonged to the organic world, and were not in all cases mere *débris*. We found also one body a good deal larger than the rest; it resembled somewhat a Paramecium, although clearly not one.

We found no motion whatever, and only this latter substance could be adduced as an absolute proof of anything organized being present. Next day I examined the same liquid; and, whether from the fact of time being given for development, or from other causes, there was a very abundant motion. There were at least six specimens in the field at a time, of a body resembling the Euglena, although smaller than I have seen it. When these minute bodies occur, it is clear that more may exist, and germs in this early stage are too indefinite to be described. The existence of vital sparks in the organic substance of the air alluded to is all I wish to assert, confirming by a different method the observations of others. It might, of course, be said that since the bottle was opened at Mr. Dancer's the air at that place may have communicated them. I answer that, before it was opened, a good glass could detect floating matter; some of it, however, as the microscope proved, indefinite enough.

Finding this, and fearing that the long time needful to collect liquid from the atmosphere might expose it also to much dust, I used a bottle of about 100 cubic inches dimensions, and putting with it a very little water, not above five cubic centimètres, I pumped out the air of the bottle, allowing the air of the place to

enter. This was done six times for each sample, the water shaken each time, and the result examined. This was done with the same bottle that was used in my early experiments with permanganate, and by the same method, except that water instead of that salt was used. At first considerable numbers of moving particles were found; but it was needful to examine the water used, and here occurred a difficulty. It was not until we had carefully treated with chemicals, and then with distilled water, again and again, that we could trust it. Particles seemed to rise with the vapour, and if so, why not with the evaporating water of impure places?

Having kept an assistant at the work for a week, and having myself examined the air of three cow-houses, I came to the conclusion that the air of cow-houses and stables is to be recognised as containing more particles than the air of the street in which my laboratory is, and of the room in which I sit, and that it contains minute bodies, which sometimes move, if not at first, yet after a time, even if the bottle has not been opened in the interval. There is found in reality a considerable mass of *débris* with hairs or fine fibres, which even the eye, or at least a good pocket lens, can detect. After making about two dozen trials, we have not been able to obtain it otherwise. Even in the quiet office at the laboratory there seemed some indications.

I found similar indications in a cow-house with healthy cows, so I do not pretend to have distinguished the poison of cattle plague in these forms; but it is clear that where these exist there may be room for any ferment or fomites of disease, and I do not doubt that one class is the poison itself in its earliest stage. It would be interesting to develop it farther.

I have recorded elsewhere that I condensed the liquid from the air of a flower garden, and found in it, or imagined I found, the smell of flowers. I do not remember that I looked much to the solid or floating particles, thinking them to be blown from the ground, but it does not affect the result whether they be found constantly in the air or are raised by the action of currents.

"Microscopical Examination of the Solid Particles from the Air of Manchester," by J. B. Dancer, F.R.A.S.

The air had been washed in distilled water, and the solid matter which subsided was collected in a small stoppered bottle, and on the 13th of this month Dr. Smith requested me to examine the matter contained in this water. An illness prevented me from giving it so much attention as I could have wished.

The water containing this air-washing was first examined with a power of 50 diameters only, for the purpose of getting a general knowledge of its contents; afterwards magnifying powers varying from 120 to 1600 diameters were employed.

During the first observations few living organisms were noticed; but, as it afterwards proved, the germs of plant and animal life (probably in a dormant condition) were present.

I will now endeavour to describe the objects found in this

matter, and begin in the order in which they appeared most abundant.

1st. *Fungoid matter.*—Spores or sporidiæ appeared in numbers, and, to ascertain as nearly as possible the numerical proportion of these minute bodies in a single drop of the fluid, the contents of the bottle were well shaken, and then one drop was taken up with a pipette; this was spread out by compression to a circle half an inch in diameter. A magnifying power was then employed, which gave a field of view of an area exactly 100th of an inch in diameter, and it was found that more than 100 spores were contained in this space; consequently the average number of spores in a single drop would be 250,000. These spores varied from 10,000th to 50,000th of an inch in diameter. The peculiar molecular motion in the spores was observable for a short time, until they settled on to the bottom of the glass plate; they then became motionless.

The mycelium of these minute fungi were similar to that of rust or mildew (as it is commonly named), such as is found on straw or decaying vegetation.

When the bottle had remained for thirty-six hours in a room at a temperature of 60°, the quantity of fungi had visibly increased, and the delicate mycelial thread-like roots had completely entangled the fibrous objects contained in the bottle, and formed them into a mass.

On the third day a number of ciliated zoospores were observed moving freely amongst the sporidiæ. I could not detect any great variety of fungi in the contents of the bottle, but I cannot presume to say that all the visible spores belonged to one species; and as there are more than 2000 different kinds of fungi, it is possible that spores of other species might be present, but not under conditions favorable for their development. Some very pretty chain-like threads of Conidia were visible in some of the examinations.

The next in quantity is vegetable tissue. Some of this formed a very interesting object, with a high power, and the greater portion exhibited what is called pitted structure. The larger particles of this had evidently been partially burnt, and quite brown in colour, and were from coniferous plants, showing with great distinctness the broad marginal bands surrounding the pits; others had reticulations small in diameter. They reminded me of perforated particles so abundant in some kinds of coal.

The brown or charred objects were probably particles of partially burnt wood used in lighting fires.

Along with these reticulated objects were fragments of vegetation, resembling in structure hay and straw and hay seeds, and some extremely thin and transparent tissue showing no structure. These were doubtless some portions of weather-worn vegetation. A few hairs of leaves of plants and fibres, similar in appearance to flax, were seen, and, as might have been expected in this city, cotton filaments, some white, others coloured, were numerous,

red and blue being the predominant colours. A few granules of starch, seen by the aid of the polariscope, and several long elliptical bodies, similar to the pollen of the lily, were noticed. After this dust from the atmosphere had been kept quiet for three or four days, animalculæ made their appearance in considerable numbers, the monads being the most numerous. Amongst these were noticed some comparatively large specimens of *Paramecium aurelia*, in company with some very active Rotiferæ; but after a few days the animal life rapidly decreased, and in twelve days no animalculæ could be detected.

Hairs of animals.—Very few of these were noticed, with the exception of wool; of this both white and coloured specimens were mixed up along with the filaments of cotton.

After each examination as much of the drop of water as could be collected by the pipette was returned to the bottle, in order to ascertain if any new development of animal or vegetable life would take place, and the stopper of the bottle was replaced as quickly as possible to prevent the admission of the particles from the air in the room; and I am tolerably certain that the objects named in this paper are those which the bottle contained when Dr. Smith brought it to me.

The particles floating in the atmosphere will differ in character according to the season of the year, the direction of the wind, and the locality in which they are collected, and, as might be expected, are much less in quantity after rain.

The small amount of fluid now remaining in the bottle emits the peculiar odour of mildew, and at present the fungoid matter appears inactive.

For the purpose of obtaining a rough approximation of the number of spores or germs of organic matter contained in the fluid received from Dr. Smith, I measured a quantity by the pipette, and found it contained 150 drops of the size used in each examination. Now, I have previously stated that in each drop there were about 250,000 of these spores, and as there were 150 drops, the sum total reaches the startling number of 37½ millions, and these, exclusive of other substances, were collected from 2·495 litres of the air of this city[1]—a quantity which would be respired in about ten hours by a man of ordinary size when actively employed. I have to add that there was a marked absence of particles of carbon amongst the collected matter.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

February 24th, 1868. J. B. Dancer, F.R.A.S., President of the Section, in the chair.

Mr. Sidebotham sent two beautifully finished water-colour drawings, accompanied by the following note:

"I send you a couple of drawings of the dry-rot fungus *Merulius lachrymans*, remarkably fine. Mr. Lynde, our treasurer,

[1] Behind Dr. R. Angus Smith's laboratory.

brought me the specimens, which he had met with during the demolition of some old buildings. The drawings are of the natural size. It is very rarely that such perfect specimens are found, showing, as this one does, the curious structure of the species, and its connexion with both the pore and the gill-bearing divisions of fungi."

Mr. Dancer exhibited some sand from the sea-shore at Santos, South America. This sand was remarkably silvery in appearance, a large portion of it consisting of minute plates of mica, and very transparent fragments of quartz, which made it an interesting object for the polariscope. It was rich also in Foraminifera, spines of Spatangus, and fragments of Coralline.

"Remarks on Molecular Activity as shown under the Microscope," by J. B. Dancer, F.R.A.S.

The author stated that, during the last thirty years, he had met with many microscopical observers who were not acquainted with the phenomenon to which the name of molecular action has been given. This class of microscopists had confined their attention to objects requiring a very moderate amount of magnifying power, and generally to dry objects; but when their investigations extended to minute objects immersed in fluid which required powers of 800 to 1500 diameters, they were startled by the appearance of particles in active motion, not moving in a direct line, but vibrating as if attracted and then repelled by each other, some single, and others in clusters.

Many instances have come under the author's notice in which these objects have been regarded by microscopists as animalculæ. They have given rise to many very ingenious speculations, some of which are connected with spontaneous generation; these observers would have been saved much labour if they had been acquainted with the experiments of the late Dr. Robert Brown on active molecules.

The author does not imagine that the members of this section are wholly unacquainted with the experiments of the early microscopists on this subject, but in the abscence of more important matter he thinks a brief account of the early observations on these so-called active molecules may interest them.

The moving particles had been noticed by Leuwenhock, Stephen Gray, Buffon, and others who supposed them to be animated matter.

In the year 1827 the late Dr. Robert Brown, whilst engaged in the microscopical investigation of the unimpregnated ovulum, noticed that the pollen of the *Clarckia pulchella* was filled with particles which appeared in active motion when immersed in water. These observations were followed by the examination of the pollen of other plants, the particles of which he found to exhibit similar activity. For some time he was exceedingly perplexed with these phenomena, and was disposed to believe that he had really seen in these minute bodies the supposed constituents or elementary molecules of organic bodies, first so considered by

Buffon, Wrisberg, Muller, and Milne-Edwards, and on examining various animal and vegetable tissues, whether living or dead, he found, as he had expected, that active molecules were visible by merely bruising the substances in water.

Continuing his observations, he found that particles from a bruised specimen of fossil wood appeared to consist entirely of these moving bodies. From this he inferred that these molecules were not limited to organic bodies, or even to their products.

After this he proceeded to examine minerals, simple earths, metals, and many other substances too numerous to mention, and with similar results.

Some writers who commented on these experiments, but who had not carefully followed his communications, asserted that Dr. Brown imagined these particles to be animated—and this statement was generally believed.

In 1829 the author's late father repeated many of Dr. Brown's experiments, and, to prove that these moving particles could not be animalculæ, he placed some crystals and minerals in a crucible which he subjected to a red heat, ground portions of them to powder, then put it into distilled water, and showed the particles in motion to his scientific friends. It is now well known that all kinds of matter, if reduced to sufficiently small particles, and placed in a medium in which they will not readily sink, will exhibit these movements.

Now, as this phenomenon occurs in the cells of plants, the yolk of the egg, and in decomposing animal and vegetable matter, it is not surprising that the early microscopists, and, indeed, modern ones, should have mistaken them for animalculæ. The particles which exhibit the greatest activity are exceedingly minute, ranging from 10,000th to 30,000th of an inch in diameter; they remain active a considerable time if they are nearly of the same specific gravity as the solution in which they are immersed. One simple mode of producing them is to rub a little gamboge in water, on a glass slide, and place a thin glass cover on it, using a power of from 800 to 1200 diameters. They can easily be distinguished with less magnifying power, but are not so effectually shown. If they are required for prolonged examination, Dr. Brown recommends that the solution of gamboge be mixed with a little almond oil. The minute globules of water are thus surrounded by oil, and rapid evaporation is prevented.

The cause of the phenomenon is not yet satisfactorily accounted for. Some have imagined that it is the physical repulsion of the particles when uninfluenced by gravitation. The author has tried many experiments with electricity and magnetism without success. He thinks that the movement may possibly be connected with the absorption and radiation of heat.

Those interested in Dr. Brown's experiments and observations on active molecules can refer to his republished papers in vol. i, of the Ray Society's publications for 1866.

After the meeting slides containing active molecules were exhibited to the members.

A conversation took place on the preservation of dried plants, in which Mr. Bailey stated that he uses with success glue with carbolic acid for attaching them to the paper, as a preservation against mites, placing also a few crystals of the dry acid in his cabinet.

At the meeting held on November 3rd, Professor W. C. Williamson, F.R.S., called the attention of the Society to the structure of the Calamite from the Upper Coal-measures represented in Fig. 478 of the 5th edition of Lyell's 'Manual of Geology.' He pointed out the existence of one Calamite within another, the former representing the pith and the latter the exterior of the bark, the pith and bark being separated by a well-defined woody zone. This woody zone consists of a series of tissues radiating, as in the recent Conifera, from the pith to the bark; but instead of being all alike, they consist of two structures, which are arranged in alternating wedges. One of these is entirely composed of elongated cells, which being arranged in linear rows radiating from pith to bark, and being separated from the former by a defined line, this tissue is to be regarded as a modified form of pleurenchyma rather than of parenchyma. The intermediate radiating laminæ or wedges resemble slices cut out of a coniferous Dadoxylon, having the same reticulated fibres and muriform medullary rays, the latter consisting of a single vertical row of cells. These structures replace corresponding wedges in the Calamites recently described by E. W. Binney, Esq., but in which latter the wedges consist wholly of masses of scalariform tissue unfurnished with medullary rays. Immediately below each node Professor Williamson pointed out the existence of a verticil of prolongations of the pith, penetrating the *cellular* wedges of the woody layer like spokes of a wheel. These he terms "verticillate medullary radii," to distinguish them from the ordinary medullary rays of the *fibrous* wedges. These fibrous and cellular wedges run uninterruptedly in a longitudinal direction along each joint or internode of the Calamite, but at each node their arrangement is altered. If prolonged, the cellular wedges of one joint would run into the fibrous wedges of those above and below it. But as the fibres of the fibrous wedges are continued from one internode to the other, they break up as they approach each node, their fibrous laminæ being twisted in an extraordinary manner as they cross the node, in order to redistribute themselves right and left to the fibrous wedges of the joint above. In this part of the plant the fibrous laminæ, and medullary rays, and the cells of the cellular layer become intermingled in a remarkable way. At the base of each cellular lamina especially the fibres radiate from a common centre in an almost inexplicable manner.

Bristol Microscopical Society.

The usual monthly meeting of this Society was held on the 19th of November, at the Philosophical Institution, Bristol, Mr. W. J. Fedden, Vice-President, in the chair. The formal business having been transacted, Dr. C. T. Hudson read a paper "On *Triarthra longiseta*." Dr. Hudson entered minutely into the anatomy of this curious Rotifer, and illustrated his communication by diagrams and microscopical preparations.

MEMOIRS.

Monograph *of* Monera. By Ernst Häckel.

With Plates IX & X.

(*Continued from p.* 42.)

No nuclei or nucleus-like form could be perceived throughout the entire plasma body of the Protomyxa, nor contractile vesicles, if we understand by these, fixed organs which, although without a differentiated wall, still occupy definite positions in the body. Nevertheless, a great number of vacuoli were dispersed through the body, as well in the central mass as in the thicker branches. These appeared in the form of paler and more circular spots (fig. 11, 11 v) of different sizes, the largest of 0·03 mm. diameter. If one observed the same vacuole for a little time, its dilatation and contraction, and its appearance and disappearance could be distinctly observed. The former as well as the latter occurred very slowly, and required from about two to three minutes in the largest. By contraction the size of the vacuole became smaller and smaller, at last the clear space entirely vanished; and it appeared as if the yellowish-red plasma had flowed together over it. If the place where the vacuole had vanished was watched, the vacuole would sometimes be seen to reappear slowly in the same place. A paler point appeared which became slowly larger and larger; it often exceeded its former boundary; another time it did not attain to it. But very often the vacuole remained invisible, and instead of this one, one or more new vacuoli appeared in other places, some near and some very distant. Sometimes in the place of a large vanished vacuole appeared a number (ten to twenty) of small vacuoli in the neighbourhood, either irregularly scattered or grouped in a circle over the place of the vanished vacuole. All this shows that the contractile cavities in the body of the Protomyxa are really vacuoli, *i. e.*, wall-less cavities filled with a watery fluid in the middle of the homogeneous sarcode parenchyma, like those which also occur in many Rhizo-

poda, Myxomycetæ, &c. They are also not true contractile vesicles such as occur in the true Infusoria (Ciliata), and in some Amœbæ (*e. g.*, A. quadrilineata). These latter are distinct and permanent organs, no matter whether they can be perceived to have an essential wall or not. True contractile vesicles always occupy precisely the same situations in the body, while the vacuoli appear and disappear here and there in the solid albuminous mass of the plasmaparenchyma. From this definition of vacuoli as distinguished from contractile vesicles it is naturally in no way disputed but that transitional intermediate forms between both occur. On the contrary, I consider it very probable that the contractile vesicles are developed from simple vacuoli phylogenetically (by natural selection).

The vacuoli, as well as the red granules which are scattered in the homogeneous plasma of the Protomyxa and lie everywhere and wander everywhere, are appearances which stand in the closest relation to the change of substance (Stoffwechsel) of this Moner. I tried to keep the Protomyxa in shallow watch-glasses with sea-water and succeeded, with the best results. I placed the small watch-glasses, each of which contained a single Protomyxa, in a larger glass filled with water, and inverted a large glass over it, so as to form a very roomy, damp chamber; and in this manner I succeeded in keeping the Protomyxa alive more than three weeks, and in observing the phenomena of their nourishment and reproduction in full detail. The next fact which I ascertained by continual daily observation was that the number of the vacuoli and of the red granules was in direct proportion to the quantity of food taken. I kept some Protomyxæ in pure sea-water without food, while I supplied others with plenty of Diatomaceæ for food. In the first, the number of the red granules as well as of the vacuoli had, after a few days, already perceptibly diminished, while in the others they continued the same, and from better nourishment even increased. The individuals which were best fed with diatoms were quite filled with red granules, so that the sarcode was thickly clouded; and the middle parts of the body especially appeared quite opaque. Presently a greater number of larger and smaller vacuoli appeared on all the edges and extremities. On the other hand the hungry individuals were pale, more yellow than red coloured; the number of red granules had remarkably diminished, as well as the number of vacuoli, and finally disappeared entirely (comp. figs. 11 and 12).

It is plain from this that the granules scattered in the sar-

code are the products of a change of substance. It is extremely probable that they are assimilated substances which are produced by the chemical action of the digestive sarcode from the food taken, and are afterwards changed again into sarcode. In my article "Ueber den Sarcodekörperder Rhizopoden," I have tried to show that this hypothesis is also probable with the granules which are found in the protoplasma of the true Rhizopoda (Acyttaria and Radiolaria), and that their number likewise corresponds to the quantity of food taken and digested. In the Radiolaria this hypothesis appeared to become especially probable, since the granules in several species are red coloured (in *Acanthostaurus purpurascens*, *Acanthochiasma rubescens*, and *Actinelius purpureus*).[1]

Not only the quantity of the graunles and of the vacuoli, but also the strength and rapidity of the sarcode current, seems to be dependent in the Protomyxa on the amount of nourishment taken. Although this fact is much more difficult than the foregoing to recognise and establish; and although many adaptations to external circumstances such as light, temperature, &c., seem to affect the strength and rapidity of the plasma current, I think I have convinced myself of its correctness by continued observations and by comparison of the extremes. In the hungry individuals in which granules and vacuoli had diminished in number, the current in the branched mucilaginous threads was also weaker and slower (Fig. 12). Presently the anastomoses of the branches of the stream disappeared; and instead, a large number of extremely fine, divergent, but not anastomosing mucilaginous threads were extended from the periphery of the sarcode net. On the contrary, the crescent-shaped anastomoses were especially numerous in the well-fed individuals, and the peripheral cluster of hair-like and non-anastomosing mucilaginous threads was wanting (Fig. 11). But it must here be observed that some of these well-fed individuals after resting for some time drew in their pseudopods, and finally contracting themselves into a globular mass of jelly, surrounded themselves with a covering. Before I enter on this encysted state of rest, and the reproductive phenomena of the Protomyxa connected with it, I will say something about the sensitiveness of this Moner. That the true Rhizopoda (Acyttaria, Heliozoa, and Radiolaria) as well as many Rhizopod-like organisms (Amœba, Arcella, Actinophrys) were formerly universally and unhesitatingly classed as true animals, arose partly from the animal-like shape of many of the forms of their shells (mollusciform Polythalamia), and partly from their nourishment being more animal

than vegetable, but was chiefly grounded on the motion and sensitiveness of these organisms.

As on the one hand the phenomenon of motion seems to indicate a definite will, so on the other hand the power seems to indicate a distinct sensitiveness; and finally some would attribute to these living lumps of jelly a true soul or a so-called spirit, just as they do to men and other true animals. In these respects, too, our Protomyxa is allied to the true Rhizopoda, and shows particularly the same appearances of sensitiveness which I have described in one place in the Radiolaria (l. c. p. 128), in another place in *Protogenes primordialis* (l. c. p. 362). This "organic intelligence" of the Protomyxa shows itself chiefly and principally in this: that every foreign body which touches its surfaces, especially a moved or self-moving body, produces an increased flow of sarcode to the touched and "sensitive" part of the body. In taking food this was plainly to be seen. But if I carefully touched the Protomyxa under the dissecting microscope with a very fine needle, this irritation also immediately induced a strong flow of sarcode; and the needle point was regularly surrounded with it. But as soon as I tried to pierce the interior of the sarcode body with the needle, and moved it forcibly backwards and forwards, all the pseudopods were retracted, and the whole sarcode body contracted itself into a shapeless lump. As a similar or like "sensitiveness" is a quality universally present throughout all organic protoplasm, and is recognised in like manner in animals, protozoa, and plants, it naturally proves as little for the animal nature of the Protomyxa as for that of the true Rhizopoda and other Protozoa. The Protomyxa is, on the grounds of this sensitiveness, just as little of an animal as the sensitive Mimosa.

In the course of these experiments on sensitiveness I tore several specimens of Protomyxa to pieces, one into two nearly equal halves, a second into three, and a third specimen into five rather unequal large pieces. Each of these pieces immediately shrunk together into an irregular, roundish, sarcode lump, which at first lay motionless for some time; but it soon began to expand into a flat disc, and to extend small, stumpy projections here and there from the periphery; these became slowly longer and longer, began to branch out dichotomosely, and to form anastomoses with their twigs, and the entire plasma net was soon again renewed as if nothing had happened. Each of the artificially produced fragments moved about as spontaneously and livelily as the undivided Protomyxa. The artificial divisibility of the

Protomyxa is proved by these experiments. This phenomenon, remarkable in itself, is of the greatest interest both for the doctrine of individuality (Tectology) generally, and for the natural history of the Protozoa specially. It has recently lost much of its marvel, that divisibility by artificial separation is in all probability a very general quality of the lower organisms (*i. e.*, the Protozoa), since it appears in much higher organized as well as in more strongly differentiated animals and plants.

I will take this opportunity of observing that during my stay at Lanzarote, I made many experiments on the artificial division of the Hydro-medusæ, which were followed by the most surprising results. The extraordinary divisibility and powers of reproduction in the common fresh-water hydra have been universally known since Trembley's time, and have also been established in the marine Hydrozoa by Dalyell's experiments. On the other hand, the possibility of artificially dividing the medusæ themselves (Gymnophthalmata), was previously unknown. My experiments proved that it prevails to an amazing extent in many medusæ, especially in those belonging to the family *Thaumantiadæ* of Gegenbaur (*Laodicei* of Agassiz). In several species of this family I could divide the umbrella into more than a hundred pieces; and from each piece, provided it only contained a portion of the margin of the umbrella, grew in a few days (from two to four) a complete small medusa. Merely a loosened shred of the fringe on which the base, the adjoining piece of the edge of the umbrella, remained, formed a medusa in a few days. The result that I obtained with other hydro-medusæ was still more surprising. Here I could divide the globular non-differentiated cell-mass (or the ciliated globular larva) which had come out of the egg-furrows into several pieces, and from each piece was developed a complete larva. As I shall detail these experiments in division in another place, they are only casually mentioned here.

As soon as I had perceived the complete nature of the orange-red star-shaped specks on the Spirula shell as Rhizopod-like Protozoa, the idea naturally forced itself upon me that the neighbouring previously described red balls were torpid or encysted individuals of the same species; and that those balls in which the contracted orange-red contents were divided into numerous small balls were connected with monogenetic reproduction.

The red balls which I carefully detached from the Spirula shell, and placed in shallow watch-glasses filled with sea

water in a large damp room, in a few days (four to six) already allowed me in some specimens to follow the individual development of the Protomyxa further. In all the balls the orange-red plasma contents divided, after it had retracted itself from the hyaline capsular wall, into a great number (several hundreds) of small round, thoroughly structureless, naked balls. This division did not stop with a repeated bipartite division of the encysted plasma-body; but, meantime, a great number of individual centres of attraction in the homogeneous plasma mass were differentiated, and similar plasma portions congregated round these central points. The process would consequently be better conceived as a germ formation (Monosporogonia), than as a process of division or gemmation.[1]

The small red balls (of 0·017 mm. diameter) remained several days longer in the thick-walled cyst, entirely filling its interior without any further change being perceptible in them. When I placed them again under the microscope after the lapse of about a week, I noticed in some of them a slow movement of the balls inside the cyst. The motion consisted in no regular rotation of the balls, but in a slow change of place among them, in which they crowded in all directions among each other without any fixed order.

Some hours afterwards the motion had become livelier; and the red balls had assumed a pear-shaped form, in which one end was produced into a fine point. In their confused motions within the cyst they changed the shape of their soft, pear-shaped bodies many times, becoming sometimes drawn out into a longer, sometimes into a shorter club-shaped body, and sometimes they became twisted.

Next day I found one of the cysts burst; the empty collapsed wall lay shrivelled at the bottom of the watch-glass, and a great number of small club- or pear-shaped red bodies moved about freely in the sea-water. It now appeared that the red balls were the sporules of the Protomyxa, and that they danced about after issuing from the cyst like Flagellata, or like the sporules of Algæ. I now burst, with a slight pressure of the object-glass, another cyst, in which the motion of the germs inside was already perceptible, and immediately saw the small, red, pear-shaped bodies issue in a thick swarm from the burst membrane (fig. 4). Immediately after the exit the form was more slender, being drawn out into a longer tail at the front end, and the motion was perceptibly accelerated (fig. 5). The form of the free sporules (fig. 5) or the tail-bearing germs (or rather germ-cytodes) was slender, pear-

[1] Vide 'Generelle Morphologie,' vol. ii, p. 70.

shaped, from the rounded base to the finely drawn out point about 0·06 mm. long, at the broadest point (just before the hinder rounded-off end) 0·012 mm. broad. The hinder portion of the sporule soon became more globular, rounded itself off more egg-shaped, and very gradually became attenuated in a conical slender neck, which then produced itself, becoming thinner, into a very fine tail. The motion of this tail (flagellum) was more pendulous or parabolical than serpentine. The tail dragged along the entire germ with it by its continuous and very lively motions. The germ was thoroughly simple and homogeneous throughout its whole mass, without a trace of any nucleus or contractile vacuole, likewise without a trace of membrane, and was entirely composed of the yellowish-red ground substance of the plasma, in which very fine red granules were imbedded. On application of solution of iodine the germs were immediately brought to a standstill, and coloured deep yellowish-brown. It was now quite manifest that the entire germ was structureless throughout, and thereby the morphological status of the simplest conceivable organic individual was that of a naked cytode or gymnocytode. Besides the extremely fine red granules, there was no difference in composition throughout the homogeneous plasma-mass to be observed. The tail was nothing more than a drawn-out hair-like projection of the plasma or of the sarcode itself. When the movements of the sporules (or the swarming gymnocytodians) of Protomyxa were more closely observed, they were found to be extremely similar to those of the sporules of the Myxomycetæ. De Bary's description applies as well to the one as to the other. The motions of the spores consist in an advancing movement towards the front end, combined with a rotation of the whole body on its longitudinal axis, whereby if it is extended it winds itself in the curve of a cone, whose base is formed by the circumscribed front end, and whose point is formed by the hinder end. The base describes the largest circle, and every other point on the surface of the body a smaller one in proportion as it lies nearer the hinder end. Meantime the cilium was always undulating like a whip-lash from one side to the other, which motion produced a backward waving or swinging in the body. The rotation is often wanting, and the last form of movement is alone present, or both alternate with one another. Simultaneously with these movements and changes of places, the body shows continual changes in its outline—worm-like twistings, alternating on different sides, contraction into a more globular form and re-expansion, peristaltic contractions, and, finally, the protrusion of small

pointed processes, which are again retracted, Amœba-like, in continual change, and are renewed afresh, and which generally appear most numerous at the rounded-off hinder end.

The spores of the Protomyxæ resembled those of the Myxomycetæ in form as well as in their movements, with this difference only, that the former, as long as they swarm, show no appearance of vacuoli. The next stages of both spores are also quite similar. Both come to rest after some time, assume an Amœba-like position, and then develop (at least partially) by assimilating plasmodia.

The swarming time of the Protomyxa spores seems to last at least one day; at least, I never saw them come to rest on the same day on which they issued from the cyst. On the following day I mostly found them lying quiet at the bottom of the watch-glass; the tail of the spore was drawn in, and the pear-shaped form of the body was exchanged for that of an irregular roundish disc, whose star-shaped circumference was drawn out into several processes. The reddish-yellow plasma bodies now completely resembled in outline the spores of Myxomycetæ when they have come to rest, or likewise *Amœba radiosa* of Ehrenberg; only the surrounding projecting processes (usually from five to twenty in number) were sometimes more of a slender cone-shape, and were sometimes more club-shaped (fig. 6). Most of the processes were simple, but, at this stage, the largest already began to divide themselves dichotomously, or repeatedly to ramify themselves. The protrusion and retraction of the ever-changing processes was accomplished throughout in the same manner as in the lively moving species of Amœba. A short time after the sporules of the Protomyxa had become stationary, and had passed into their Amœba-like condition, they already began to take nourishment. With a drop of water I introduced a number of small Diatomaceæ into the watch-glass, and those Amœbæ which came in contact with the Diatomaceæ attached their processes to them, and began to close round them in the usual manner. The Naviculæ were soon entirely enclosed by single Amœbæ, whose whole bodies, as it were, seemed to form only a thin mucous film over them (figs. 8, 9). The yellowish-brown plasma-contents of the siliceous skeleton of the diatom were assimilated by the Amœba, which then drew itself back from the empty shelly covering, and recommenced the characteristic Amœba motions, the constant protrusion and retraction of the ever-changing finger-like processes. The volume of the small Amœba increased, perhaps, about twice or thrice by the digestion of a Navicula, and now the processes also began to lengthen,

to ramify more, and already to form an anastomosis here and there.

After nourishment had been taken, vacuoli first began to appear in the Amœba, but these were entirely absent both in the stationary and in the swarming spores. Generally there appeared first a single vacuolum, less frequently two or three together, like bright, slowly pulsating, circular spots in the reddish-yellow Amœba-body. But it could be already established, by continuous observation, that the vacuoli were not constant retractile vesicles, but were accumulations of fluid within the contractile homogeneous plasma-parenchyma. They sometimes appeared in one place, sometimes in another, without reappearing after they had vanished. I could many times immediately follow in the swarms of Protomyxa under my eyes the formation of a plasmodium by the growing together (concrescence) of two or more Amœbæ. Sometimes it happened that two Amœbæ, which had left a Navicula free at the opposite ends, and had drawn themselves over it, by meeting in the middle, flowed together into one (figs. 8, 9). After the subsequent digestion the united plasma-mass withdrew itself, like a single Amœba-like individual, from the empty siliceous shell. But in the free Amœbæ also, which met upon the glass and touched with their outstretched pseudopods, the process of union could be immediately observed. There, when the Amœbæ crept near and among each other in thick groups on the surface of the glass, I often saw three or four unite together at once (fig. 7). Thus originated larger plasmodia, which already showed a transition to the above-described full-grown Protomyxa (fig. 10), from their larger number of vacuoli, and from the more numerous ramifications and anastomoses of the extended processes. Whether the formation of a plasmodium, *i.e.* the origination of larger sarcode bodies by concrescence of several Amœbæ, is a necessary and inseparable process in the development of the growing Protomyxa, or a mere accidental and indifferent one, I am unable to decide. But I think the latter case is more probable. I isolated several simple Amœbæ singly in small glasses, and furnished them with plenty of diatomaceous nourishment. In a few days they became perceptibly larger, and attained from four to six times their original volumes. The pseudopods became longer, and formed more numerous branches and anastomoses. There is no reason for presuming that none of the above-mentioned Amœbæ, by such continuous growth, could reach the full size of the completely developed Protomyxa, and could then reproduce itself just as well, and in the same manner, by sporogony as the plasmodia.

These last, as a compound of several united Amœbæ, would only have the advantage of growing quicker and becoming stationary sooner than the single Amœbæ. To complete the natural history of the Protomyxa, it still remained only to observe the encysting of the adult form, the transition from the free-moving plasmodia to the stationary red balls which had attached themselves to the Spirula-shell near the latter. I succeeded in establishing this also. Two of the largest of the best-fed plasmodia, which contained very numerous vacuoli, and which had formed a very extended sarcode net, with many branches and anastomoses, after some time began to slacken their extremely rapid currents, and to simplify their pseudopods. The siliceous shells of the many absorbed Diatomaceæ were rejected, and the branches and twigs of the pseudopods were successively retracted. At last they drew back the main stems, which had everywhere become simple, into the central plasma-body, and the entirely homogeneous sarcode body took the form of an irregular lump, and finally rounded itself into a regular ball.

Now commenced the separation of the covering of the cyst, in which the sharply defined single outline of the orange-red plasma-balls passed into a perceptible, though certainly fine, double outline. A second, and then a third, concentric boundary line soon followed this, and then the proper concentric hyaline cyst-covering appeared somewhat quickly (in the course of a day), its layers corresponded with the stated breaks of the separated gelatinous skin. At first a quantity of vacuoli were still perceptible in the plasma during the encysting process, which appeared and disappeared here and there, but visibly decreased in numbers; and after the complete development of the cyst-covering no vacuoli could be any longer perceived in the orange-red plasma, now interspersed with numerous granules. The encysted plasma-ball was now no longer to be distinguished from those red balls whose transition to the mass of sporules I have above described. Thus was the cycle of the generation of the Protomyxa completed, and the course of its simple and remarkable life-history established. *Protomyxa aurantiaca* is a Moner which, like the *Vampyrella* and *Protomonas*, appears in two different conditions during the course of its individual life. In its free-moving condition the Protomyxa appears as a naked Gymno-moner, of the morphological importance of a Plastidien (cytode), as simple as can be conceived, which successively assumes three different modifications:—I. The swarming flagellate condition, a free swimming, naked, tailed, pear-shaped, sporule (fig. 5). II. The

creeping Amœba condition, an Amœba of the simplest kind (*Protamœba*), without a nucleus and without a contractile vesicle, without ramification and reticulation of the pseudopods (fig. 6). III. The reticulated Rhizopod condition, a colossal naked plasmodium, with ramification and reticulation of the pseudopods, and with formation of vacuoli (figs. 10–12). In the immovable condition the Protomyxa appeared, on the other hand, as an encased Lepomonæs, as a Lepocytode enclosed by a separate membrane, consisting of a thoroughly homogeneous globular plasma-body, and a structureless membranous covering separated from it (fig. 1). The plasma-body divides by monosporogony into numerous small balls (figs. 2, 3), which, after their exit from the burst membrane of the cyst (fig. 4), swarm about as Flagellata (fig. 5). With this the simple cycle of the generation of the Protomyxa is completed.[1]

II.—2. *Myxastrum radians.*

See Plate X, figs. 13—24.

On the quay of Puerto del Arrecife, the port of the Canary island Lanzarote, on the flat places of the harbour's beach which are left uncovered by the water at low tide, several Actiniæ are to be found in great quantities, especially a brownish-green Anemone, besides thick tufts of *Codium tomentosum* and other Algæ. The fine brown mud which covers the stony bottom of these flat places contains, among other forms, numerous Diatomaceæ and Polythalamia. In order to study the latter, and, if possible, to ascertain something about their reproduction, I collected a little of this mud and let it stand for some time in a shallow covered glass basin. After some days, as I stirred up the mud in one of these glasses, which I held against the light, with a glass rod, I perceived among the dark particles which had been stirred up and were floating about in the water (Diatomaceæ, bits of stone, &c.) single small, transparent, pale grey dots, just visible to the naked eye, which much reminded me of *Actinosphærium Eichhornii*, Stein *Actinophrys Eichhornii*, Ehrenberg), of our fresh waters, (which is visible under similar circumstances. Placed under the microscope, it

[1] My Protomyxa are probably very closely allied to the white egg-like balls which Ecker found in dead eggs of *Lymnæus stagnalis*, ('Zeitschr. für Wiss. Zool.,' 1851, vol. iii, p. 412, tab xiii, figs. 1—4). The globular cysts, from which issued sporules with two tails (Cercomonadæ) remind us from Ecker's description extremely of Protomyxa. Unfortunately their further development was not observed.

immediately appeared that these bodies did not belong to the true Rhizopoda, but, perhaps, to one of those very similar organisms of the simplest kind. Under a stronger magnifier (fig. 24), these bodies looked like small globular particles of jelly, whose central plasma-body radiated from its whole periphery a very large quantity of fine, radial, mucous threads (pseudopods). This peripheral zone of threads was about as broad, or only a little broader, at most twice as broad, as the diameter of the central sarcode mass, from which these radiated. This measured about ·01 mm., so that the entire diameter of the body of the largest individuals was ·03 mm., but in the longest extension of the rays reached ·05 mm. The threads which proceeded from the surface of the ball of jelly with a tolerably broad conical base rapidly narrowed, and terminated in a very fine point. Ramifications of the threads were very unusual, and were not here and there observable as simple, seldom repeated, forked divisions, which ran at a very sharp angle partly from the base, and somewhat more from the outer portion of the threads. Anastomoses were also very sparingly present, except in those portions where nourishment had just been taken (fig. 23).

The entire substance of the body of this slender, numerously rayed jelly-star was throughout structureless and homogeneous. The similarly constructed sarcode mass of the central ball passed its periphery unbroken over the outstretched threads. The only bodies which could be perceived in the structureless, pale yellowish, or nearly colourless, ground substance, were numerous very small interspersed, bright shining particles, and a small number of larger, also strongly refracting, granules. If these granules suspended in the plasma of the jelly-star were continuously observed, a very slow and deliberate change of position could be noticed among them, apparently the indication of a slow current of the sarcode, which demonstrated that the mass was of very considerable consistency. This was, indeed, manifested by the superposition of a covering-glass, by the moderate pressure of which the globular body was but a little flattened. The nearest adjoining bundles of threads were broken off, and their detached points, some of them bent several times, swam about in the water. By continued pressure a still larger quantity of the protruded pseudopods were loosened; others were very slowly retracted. On increased pressure the whole body was reduced to a shapeless mass, which did not, however, spread itself out flat on the stage, but broke into many irregular pieces. All these phenomena apparently indicated an unusual consistency and toughness

of the congealed plasma, in a similar way to that of several Diatomaceæ and our *Actinosphærium Eichhornii*, as opposed to most of the other Rhizopoda.

In its entire form and size, in the consistency of the tough and inflexible plasma-threads, their slight inclination to ramification and anastomosis, and slow-moving granules, this Moner resembles the well-known *Actinosphærium Eichhornii* as also in its taking of nourishment. This it was easy to observe as soon as one followed the small bodies which, swimming about in the water round our jelly-ball, came within the circle of its rays. These were especially Diatomaceæ, Peridiniæ, the Nauplius-form of different Crustacea, and several Infusoria (fig. 23).

As soon as one of these swarming bodies came among the rays of the Moner it rested on it, apparently in consequence of the slimy nature of their surface. On trying to disengage itself it irritated the neighbouring pseudopods by its uneasy motions, and now these spread themselves slowly over the captured prey from all sides, just as is known to occur in Actinosphærium. Usually, single threads were to be observed among them, which, after longer continued contact, formed a true anastomosis. But these did not always appear to envelope the prey and to surround it with a continuous sarcode covering, as is the case in most true Rhizopoda. Rather it seemed that the stiff pseudopods, which pressed closer and closer round the captured prey, often only dragged it to the surface of the central plasma-ball, and finally drew it into the tough viscous mass itself (fig. 23). On the surface, a shallow groove formed for the reception of the foreign body became deeper and deeper, and finally closed again over it. Sometimes a small quantity of sea-water was sucked in with it at the same time, so that the morsel seemed to lie in a vacuole of circular outline. The swallowed prey, whose movements had generally already ceased before it was taken into the central body, was now slowly and gradually drawn into the centre of the latter, and there digested. The indigestible remains were slowly rejected in the same way, generally encompassed by a little fluid, as by a globular alveolus. The surface of the central viscous ball opened at an indifferent spot, and between the bases of the pseudopods the excrementa issued forth. While in all these respects our Moner is very similar to the well-known *Actinosphærium Eichhornii*, on the other hand it showed by closer examination such differences as to prove itself to be a very different Protozoon. Actinosphærium is easily distinguished from all known similar Protozoa by two different anatomical peculiarities—first,

by the palpable division of the body into a central (inner) and a peripheral (outer) layer; and, secondly, by the peculiar structure of the pseudopods. Its central or inner mass consists of a sarcode body, which contains numerous true nucleated cells. On the other hand, the external sarcode encloses numerous closely pressed vacuoli, which give the entire outside an alveolar appearance. Each pseudopod consists of a firmer hyaline axis-substance, which proceeds from the inner portion, and of a thinner outer substance, full of moving granules, which envelopes the former. By these histological differences Actinosphærium is already closely allied to the Radiolaria, from which it is, however, substantially different, as the cell-containing central mass is not separated from the peripheral sarcode by a special membrane (central capsule). At the same time, it is distinguished from the true *Actinophrys* (*A.sol.*) by those substantial differences which ally the latter by its homogeneous sarcode body closely to the Monera. In any case it is very unjustifiable to consider these two very distinct Protozoa as two different species of the one genus Actinophrys. Stein's separation of the true *Actinophrys* (*A. sol.*) from the much higher organized *Actinosphærium* (*Eichhornii*) is, under all circumstances, necessary. Actinosphærium is a true Rhizopod, intermediate between the Acyttaria and the Radiolaria, and which I have therefore placed between both in my 'General Morphology' (vol. ii, p. xxviii), as the representative of a particular (third) main division of the true Rhizopoda (*Heliozoa*).

The viscous little star represented in figs. 23, 24, contains in its perfectly homogeneous sarcode body, neither the nucleus holding cells nor the bladder-like vacuoli of Actinosphærium. The difference between an inner and outer layer in the thoroughly homogeneous pseudopods is also wanting. Our Moner might rather be associated with the true *Actinophrys* (*A. sol.*). But it does not possess the characteristic vacuoli (the large contraticle vesicles on the surface) of the latter, and is so especially distinguished by its peculiar reproduction that it is to be considered as the representative of a new genus, for which I propose the name Myxastrum. The species figured from Arrecife I call *Myxastrum radians*.

The granules which are scattered through the sarcode body of the Myxastrum are found in very different quantities, always in proportion to the amount of nourishment taken. In this respect Myxastrum conducts itself like Protomyxa and the true Rhizopoda. After a full meal, a large quantity of granules appear, which allow us to follow very clearly the

slow and variable circulation-current in the parenchyma of the solid plasma-body and its pseudopods, and visib y also on their surfaces. It is exactly as in the Acanthometra, its course is constantly changing. Ramification, anastomosis, and flattening-out of the rigid pseudopods is rare. In long-fasting individuals the quantity of sarcode-granules is considerably decreased. At last they seem to vanish entirely. The Myxastrum increased by artificial division, like Protomyxa. In two individuals, one of which I had torn in two pieces and the other in three (under the dissecting microscope), each piece slowly rounded itself into an independent viscid ball, which gradually began to stretch out its retracted pseudopods again, and then took nourishment itself like the undivided individuals. I have already described a similar artificial divisibility in the allied *Actinosphærium Eichhornii* (in 1862).

The active movements of the whole body were as weak and slow in Myxastrum as in Actinosphærium; but it was able to move itself on the stage very slowly and unsteadily, apparently rotating or rolling, or pushing itself along on the spine-like pseudopods like a sea-urchin. The fortunate result that my researches in the life-history of Protomyxa had had, permitted me to hope to observe a similarly complete development-cycle in Myxastrum also. I isolated several of the largest and best-fed Myxastri in separate watch-glasses with sea-water. I kept these in a spacious damp room for several weeks, without the Myxastri dying.

During the first few days the isolated Myxastri showed no alteration. But then I observed first in one, and then in a second individual, that the viscous little star had retracted its rays, and contracted itself into a perfectly simple viscous ball with a smooth surface. All remainsof the previously taken nourishment were removed, and no traces of any objects could be observed in the entirely homogeneous sarcode body, except the numerous fine granules. A few days later a double sharp contour, instead of the former single one, became visible, and now it appeared that the Myxastrum had encysted itself like the Protomyxa. The cyst-membrane, at first very thin, became slowly thicker and thicker, new concentric layers were separated in it, and, finally, its thickness reached an eighth of the diameter of the enclosed plasma-ball (fig. 13).

The encysted Myxastrum, as well as the encysted Protomyxa, resembled a perfectly simple globular Lepocytode, a perfectly structureless and homogeneous plasma-ball of ·008 mm. diameter. Chemically, too, it showed the same

reactions as the encysted Protomyxa. The membrane was similarly structureless, but tougher, thicker, and more consistent. My hopes of being able to follow the further development of the encysted Myxastrum, as well as of the Protomyxa, now seemed not unlikely to be fulfilled. To observe this I daily inspected the encapsuled plasma-balls, which I kept carefully isolated in small watch-glasses in the damp room. At length, after a fortnight of fruitless expectation, a change was visible. The homogeneous plasma-ball began to show a great number of radiating stripes, and to divide itself into the direction of these stripes, as in the yelk-furrows of Sagitta. After three or four days the entire plasma-ball was divided into about fifty thickened conical portions, whose points met in the centre of the ball, while the rounded bases of the slender cones touched the inside of the wall of the cyst (fig. 14). Between the isolated, conical, radiating plasma-portions, whose substance evidently thickened slowly, a small quantity of a clear watery fluid collected. A change of form now slowly commenced in the radiating plasma-portions, whereby their original globular shape became more and more spindle shaped. At the same time the inner points of the spindles (which were pointed at both ends) withdrew from the centre, in which fluid collected (figs. 15, 16).

Each of the extended spindle-shaped plasma-bodies, which had originated from the radial separation of the simple plasma-body, now began singly to be clothed with a thin covering, which was visible as a distinct double outline between the single spindles (figs. 15, 16). The length of the spindle-shaped bodies measured only ·003 mm.; their greatest breadth (in the middle) ·0015 mm.; the thickness of their outer covering ·00012 mm. This membrane consisted, as it appeared from the chemical reactions, of silix. Isolated, one would have taken each single spindle for a small diatom, something like a Navicula (fig. 17). But the nucleus which the Diatomaceæ possess was wanting in the entirely structureless plasma-body. Each spindle was, in fact, a simple cytode, not a true (nucleus-containing) cell.

In this condition, protected by the firm siliceous case, and externally still by the common cyst-case of the older body, the spindle-shaped germs of the Myxastrum remain, probably under their natural conditions, for some time. After the lapse of a whole week no remarkable change was visible in them, and, as the time of my stay at Lanzarote drew towards its close, I determined to burst the only two cysts which were still left, and to see if the further development

of the germ would then ensue. This actually succeeded. After I had burst the two globular cysts (which, from the firmness of the hyaline cyst-membrane, required a rather considerable pressure) the spindle-shaped siliceous spores separated from each other, and dispersed themselves in the water. For the first two days there was no alteration and no movement to be observed in them. They lay irregularly and apparently unaltered at the bottom of the watch-glass. At length, on the third day, I observed that from one end of several siliceous spindles projected a hyaline, finger-shaped, rounded process, about one third or one fourth as long as the spindle. At the opposite end the plasma-contents of the siliceous covering were depressed, and a clear opening was here observable (fig. 18). This opening slowly grew larger, while the plasma at the other end expanded more and more in proportion. Thus, finally, the entire homogeneous plasma-body of the spindle-shaped spore issued from its siliceous covering, contracted itself into a ball, and remained lying motionless in front of the empty covering (figs. 17, 20). The separated plasma-ball was entirely homogeneous and structureless, only interspersed with exceedingly fine granules, which were not yet susceptible of measurement under a magnifying power of 500 diameters.

There was also no trace of a nucleus or of a vacuole to be observed after the application of several reagents. The naked spore was, indeed, an entirely structureless sarcode ball. In the empty siliceous membrane there was also no structure to be observed. Examined by the strongest magnifiers and polarized light, both in fluid and dried, the thin siliceous covering showed no markings on the surface. Whether the narrow hole through which the naked spore or germ-cytode escaped from its siliceous covering pre-existed, or was first formed from the rupture of the plasma by dissolution of the siliceous covering at the point—whether this hole existed at both ends of the spindle-shaped spore-membrane, or only at one end—and whether, in the last case, it was at the inner (central) or outer (peripheral) end of the radiating siliceous spindles—I was unable to determine.

For two hours after the plasma-body of the Myxastrum issues from its spindle-shaped siliceous covering it remains lying motionless, as a naked plasma-ball, before the empty covering. Then its previously smooth surface becomes entirely covered with fine bristles (fig. 21). These bristles are nothing else than radial projections of the plasma, which gradually lengthen, and finally equal, and even exceed, the diameter of the central plasma-ball (fig. 22). It was soon

to be observed, also, that the granules of the central sarcode mass passed into these radiating pseudopods, and that the same game of granule-circulation commenced as I have described above in the full-grown Myxastrum. Now, too, already, small foreign bodies, which accidentally came in contact with the pseudopods, adhered to them, and were drawn slowly into the central mass of the body, to be there digested. Apparently these small radiating balls of ·008 mm. diameter already possess the form of the thirty to fifty times larger full-grown Myxastrum, and the latter can develop itself from the former by simple growth. Special processes of differentiation, or any other changes besides the simplest growth, are then no longer necessary. On some of the small Actinophrys-like germs which had taken food were also to be observed already, here and there, scanty ramifications and anastomoses of the radiating pseudopods. On the other hand, as in the full-grown Myxastrum, neither vacuoli nor the differentiation of a nucleus existed in the uniformly homogeneous plasma-body. Under natural circumstances the encysted Myxastrum probably remains a long time before its cyst-membrane dissolves or bursts, and the first opportunity for further development is given to the siliceous spores. Apparently this development would not yet have taken place in the cysts which I examined if I had not artificially burst the covering.

Myxastrum radians is, as follows from the foregoing complete picture of its generation-cycle, or of its individual (life-history) cycle of development, a Moner which, like Protomyxa, Protomonas, and Vampyrella, appears during the course of its individual life in two different conditions—a motionless and a freely moving condition. In its freely moving condition, during which nourishment is taken, Myxastrum much resembles a true *Actinophrys* (*A. sol.*), and essentially differs from it only in the want of any vacuoli. In the motionless condition, on the other hand, during which reproduction takes place, Myxastrum presents a globular cyst, whose homogeneous plasma-contents break up by radial division (diradiation) into a number of motionless spindle-shaped spores. Each spore develops a siliceous covering, and then resembles a Navicula (without a nucleus). When the motionless condition changes again into the free-moving state the cyst bursts, the spores issue from their siliceous covering, and at once reassume the shape of a globular radiating Actinophrys-like plasma-body, which by simple growth changes into the form of the adult Myxastrum.

3.—II. *Myxodictyum sociale.*

See Plate X, figs. 31—33.

In the course of my journey homewards from the Canary Islands I spent ten days of the second fortnight of March, 1867, at the little Spanish town of Algesiras, which lies opposite Gibraltar on the western shore of the charming bay of Algesiras. Here I hoped to meet with some of the rich swarms of oceanic life which have been observed at different times in the Straits of Gibraltar. But nothing of the expected abundance appeared, except a few Physaliæ, Velellæ, and other pelagic hydromedusæ, although I daily explored the bay in all directions with my boat. The results of surface fishing with the fine net were also very discouraging; the haul consisting mainly of small medusæ (Eucopidæ) and of a great quantity of Noctiluca, Acanthometra, and of polycyttarian Radiolaria (Collozoum, Sphærozoum, Collosphæra, and Siphonosphæra.) In order to examine the Acanthometræ, which on some days were rather common and in a perfect condition, and to trace the appearances of motion in their pseudopods, I several times scooped up water directly from the surface of the sea with glasses, and after they had stood quiet for some time I again scooped the surface of the water standing in the glasses with a shallow watch-glass. This method, requiring undoubtedly some patience and care, is very much to be recommended when we wish to observe the sarcode movements of the pseudopods of small Radiolaria, and the true granular movements in the sarcode current, in fresh objects perfectly at rest. Among several Acanthometræ and Ommatidæ which I obtained in this way I fortunately chanced to meet with the remarkable Rhizopod-like Moner, which I describe below as *Myxodictyum sociale.*

As I adjusted the focus of the microscope with a moderate power over the surface of the water on which the Acanthometræ floated, I noticed a group of small roundish radiating bodies lying thickly together, each of which resembled a small Actinophrys. When magnified 400 diameters this group presented the appearance shown at fig. 31. On a portion of the surface which formed a circle of about 0·35 mm. diameter, a group of seventeen transparent finely-punctured radiating bodies appeared, each of which presented much the appearance of an expanded *Actinophrys* (*sol.*), or Trichodiscus. From each body radiated numerous fine branching and anastomosing threads, which united themselves with those of the neighbouring bodies. In the threads

was observable the characteristic granular movements, the appearance and disappearance of branches and anastomoses, which mark the pseudopods of the true Rhizopoda; and the granular movements passed from one body to the other (fig. 31). Each of the seventeen Actinophrysan-like bodies thus united exhibited a homogeneous disc of ·003–·004 mm. diameter, and was separated from the neighbouring ones by as considerable, or, at most, two or three times as considerable an interval. Each body appeared to be formed of a thoroughly homogeneous substance throughout its entire substance, a consistent plasma, which perfectly resembled the sarcode of the Protomyxa or of the Radiolaria. There was just as little trace of any kind of structure or of differentiation to be observed in this slimy albuminous body as in Protomyxa; any difference between a firmer cortical layer and a softer body-substance was completely wanting; vacuoli seemed to be quite absent. The very fine granules, mostly too fine to admit of measurement, which were scattered through the entirely homogeneous ground substance, were continually in slow motion. A few scattered larger granules could be easily traced on their route throughout the mass of the body, through the pseudopods, their twigs and anastomoses, and from one body to another. The sarcode-current was rather slow, not nearly so rapid as in Protomyxa and in Protogenes, but, on the other hand, not so slow as in Myxastrum. One could very plainly see how the larger granules, which had lain at the periphery, were conveyed along single pseudopods by the plasma-current as far as the points of the very fine threads; how that they turned round here and ran back again, or were carried over by a lamelliform anastomosis to one of the neighbouring threads. This thread extended by anastomosis with the thread of a neighbouring body into the substance of the latter, so that one could see the granule during this transition. From this point the same granule could again pass to another body, and so on. By continued observation it soon appeared indisputable that the entire coherent plasma-body consisted of a single large completely homogeneous sarcode-net, and that the seventeen separate radiating plasma-bodies were in some measure only larger accumulations of the sarcode mass at the knots of this net. The meshes of the net were polygonal, mostly five- or six-angled, of between ·001—·002 mm. diameter, but otherwise quite irregular in form. While some pseudopods sent out new branches, and these formed anastomoses by junction with the neighbouring threads, in other places larger meshes were formed by the influx of sarcode

into some threads ceasing; and at times an interruption occurred in the midst of the course of a current. The central part of a thread thus interrupted, was drawn back into its own thickened base, in place of which the peripheral portion was carried over in the course of the current of the neighbouring thread. With the fine granules small foreign bodies also circulated along the threads; these had accidentally touched the surface of the threads, been captured, and were now seized up by the sarcode-current, and carried along by it. That the sarcode is actually a consistent substance, and that the granules and foreign bodies suspended in it are really carried along by the flowing and ever-changing plasma-stream, can be observed as certainly in Myxodictyum as in Protogenes and in the true Rhizopoda (Acyttaria and Radiolaria). In all probability the taking of nourishment also proceeds in Myxodictyum exactly as in the last-mentioned Protozoa. Certainly, in the single example which I observed at Algesiras, and which I could only examine for a few hours, there were no larger foreign bodies, such as diatoms, peridiniæ, &c., to be observed inside the plasma-substance. However, in the true Rhizopoda, as well as in Protogenes and Myxastrum, when they have recently taken abundance of nourishment, as soon as the indigestible remains are rejected, all foreign bodies may be absent. The great number of circulating granules in the plasma-body of the Myxodictyum seem to indicate that abundant nourishment had been recently taken, and there is no reason to believe the above-mentioned phenomena to be different in it from those observed in Myxastrum, in Protomyxa, and in the true Rhizopoda.

The appearance presented by the remarkable net-like sarcode body of *Myxodictyum sociale* under a high power (400 diam. fig. 31) strikingly resembles the similar appearance which a Polycyttarian or social Radiolarian (*e. g.* Collozoum, Collosphæra) displays under a low power.[1] The seventeen separate radiating sarcode-layers, which lie in the meshes of the net, correspond to the separate central capsules (morphological individuals) of the Polycyttarian colony. Imagine a colony of Collozoum without the central capsules, the alveolus, which carries the sarcode-net, and the yellow cells, which are interspersed herein, and you have a complete picture of the Myxodictyum.

This comparison is of importance for the morphological explanation of the Myxodictyum. For the entire body ap-

[1] Compare the figures of *Sphærozoum italicum* (Taf. xxxiii, fig. 1); and of *Collozoum inerme* (Taf. xxxv, fig. 13) of my 'Monograph of Radiolaria.'

parently does not indicate a single simple individual, but a colony of Moners. The seventeen separate, star-shaped, and radiating Actinophryan-like plasma-bodies are likewise many morphological individuals of the first class, and the entire plasma-net is, notwithstanding its absolute simplicity, already an individual of a higher (second) class. It is, in some respects, a colony-forming Actinophrys or Protogenes. Morphologically defined wth more strictness, each of the seventeen naked homogeneous plasma-stars is a gymnocytode, and the entire body a very simple individual of the second order, or an organ (this expression taken in a purely morphological sense, as I have used it in my Tectology).

As similar colonies of Monera had not been previously known, it would have been of great interest to have observed the Myxodictyum longer, and especially to have witnessed its reproduction, and to have seen if it passed into a state of rest, or rather into another organism. Unfortunately, it was impossible for me to obtain information about this. But I observed at least a change during the few hours in which I had the Myxodictyum under notice.

After I had sketched the drawing of Myxodictyum reproduced at fig. 31, and had sufficiently examined the phenomena of the motions of the sarcode, in order to establish their identity with those of the Rhizopoda, I put the glass aside to sketch a few Acanthometræ, which I had caught at the same time. Three hours later, I placed the watch-glass with the Myxodictyum again under the microscope. The slimy net still lay, in the previously described form, on the surface of the water, and the slow current of the sarcode continued moving uninterruptedly. The separate Actinophryan-like bodies had but moved a little further from each other, about three or four times their diameter; the meshes of the net appeared larger, and the circumference of the whole group, which was formerly nearly circular, was now more irregularly polygonal, and at the same time somewhat lengthened in one direction. On closer examination, I discovered that there were only fifteen individuals present in the net. At first I suspected that, perhaps, the two missing individuals had coalesced with two of the remaining ones, and were united with them. But it proved, on a thorough inspection, that they had separately detached themselves from the colony, and now swam isolated at the edge of the watch-glass on the surface of the water. Each of the two bodies had a nearly circular circumference, from which radiated a rich circlet of ramifying and anastomosing pseudopods, like an *Actinophrys* (*sol.*), without contractile vesicles (fig. 33).

(*To be continued.*)

ENUMERATION *of* MICRO-LICHENS *parasitic on other* LICHENS. By W. LAUDER LINDSAY, M.D., F.R.S.E., F.L.S.

(*Continued from page 57.*)

Calicium stigonellum, Salwey (excl. syn.).

On thallus (1) of several *Pertusariæ*, corticolous and saxicolous, in various conditions of growth, especially variorarioid, e.g. *P. communis* and *Wulfenii*; (2) of various *Lecanoræ*, e. g. *L. parella*, *L. tartarea*, var. *Turneri*, *L. subfusca*; (3) of various *Peltideæ*; and (4) of *Bœomyces rufus* Nyl.; Mudd, Brit. Lich., 224; and in my herbarium, 1856, from Cliffrig, Cleveland, on a *Pertusaria*; Richardson and Leighton (Lichens of Arctic America,[1]) on *Peltideæ* and *Hypna*; Tul., 118, on *Bœomyces*; Körb., Syst., 217, on *Lecanora subfusca*; and generally on a variety of saxicolous, crustaceous Lichens.

Spores 8, oblong or ellipsoid, 4- rarely 2-locular; yellow, becoming brown.

9. *L. scabrosa*, Ach.

Syn. *Lichen scabrosus*, E. Bot., t. 1878, pr. p.
L. citrinellus, E. Bot., t. 1877, pr. p.
Lecidea flavovirescens, Fries.
" " var., Schær.
L. citrinella, var., Ach.
Buellia scabrosa, Körb., Syst., 227; Th. Fries, Arct., 232.

On sterile thallus of *Bœomyces rufus* and *B. placophyllus*; sometimes only associated therewith (Nyl., Prod., 142; Scand., 247; Th. Fries).

Spores 8, sub-ellipsoid, 2-locular, brown. Körber (Syst., 277) describes it also with a proper thallus. Nylander suggests that *L. Hookeri*, Schær., which has its proper thallus, may be referred to *L. scabrosa*. *L. Hookeri* is itself affected by a parasite, *Verrucaria innata* (q. v.).

10. *L. micraspis*, Smrf.

Syn. *L. saxatilis*, Næg.; Hepp, 145.
L. Schæreri, Fw.
Trachylia saxatilis, Rabenhorst.
Buellia, Körb., Syst., 228.
Acolium, Mass.
Calicium, Schær.

On thallus of *Lecanora calcarea* and *Squamaria saxicola*

[1] 'Journal of Linnean Society,' vol. ix, Botany, 1867, p. 184.

(Nyl., Prod., 140); on sterile thallus of *Pertusaria ocellata*, Wallr., var. *corallina*, Ach. (Rabenhorst, Lich. Europ. Exs., Fasc. xxviii).

Spores 8, minute, 2-locular, brown. Körber (Syst., 228) describes a proper thallus, with spermogonia. Nylander suggests that it may be considered a form of *L. disciformis*.

11. *L. Egedeana*, Linds. (Observ. on Greenland Lichens).

On sterile thallus of *Parmelia saxatilis*.

Spores 8, broadly ellipsoid, 2-locular, brown.

12. *L. glaucomaria*, Nyl., Prod., 144.

On thallus of *Lecanora glaucoma* and *Physcia parietina*, (Nyl.).

Spores oblong, 2—4-locular, colourless, sometimes becoming brown.

13. *L. sagedioides*, Nyl., Prod., 140.

Syn. *Homalea*, Nyl.
Mischoblastia lecanorina, Mass., Rich., 41.
Berengeria, Trevis.
Urceolaria cinerea, v. *vulgaris*, subv. *polygonia* f., Garov.
U. cinerea, v. *alba*, subv. *dædalea*, Schær.

On thallus of certain terricolous and saxicolous *Verrucariæ* (Nyl.).

Spores 8, ovoid, 2-locular, colourless, becoming brown. Massalongo describes it as having a proper thallus.

14. *L. Endocarpicola*, Linds., Observations on New Licheicolous Micro-Fungi.

On *Endocarpon hepaticum*, Ach.

Spores 8, ellipsoid, colourless, simple or 3-septate.

15. *L. uniseptata*, Nyl. (Enum., 127); Switzerland.

I have not met with a description of the characters of this or the following, which, however, belong to that section of *Lecidea* having compound spores.

16. *L. aliena*, Nyl. (Enum., 127); California.

c. Spores linear or acicular, and multilocular.

17. *L. arenicola*, Nyl. (Mudd, 186).

Syn. *L. citrinella*, var., Nyl. (f. Mudd).
Raphiospora, Mudd.

On thallus of *Bæomyces rufus*.

Spores acicular, frequently flexuose, 8—12-locular, colourless. There seems no good ground for regarding it otherwise than as an athalline form of *L. citrinella*, Ach.

d. Character of Spores not known to me.

18. *L. cristata*, Leight. (in letter, 1858).

On thallus of *Lecanora glaucoma*; in my herbarium from Barmouth (1856).

19. *L. orygmæa*, Nyl.

On *Sticta Urvillei*, Dél., Straits of Magellan.

Occurring on Lichens, but having a most doubtful claim to be classed in the genus *Lecidea*, or, perhaps, among Lichens at all, are—

20. *L. Cladoniaria*, Nyl., Enum., Suppl., 339; Linds., N. Z. Lich. and Fungi, 442;[1] Observ. on Greenland Lichens.

On the squamules of the horizontal thallus of *Cladonia bellidiflora*, and on anamorphoses of the podetia of *C. uncialis*.

Spores 8, oblong, colourless, simple? Possesses pycnidia.

21. *L. Alectoriæ*, Linds., N. Z. Lich. and Fungi, 441.

On thallus and lower surface of apothecia of *Neuropogon Taylori*, Hook.

Spores 4-locular, oval, or ellipsoid.

22. *L. obscuroides*, Linds., N. Z. Lich. and Fungi, 441.

On thallus of a variety of *Physcia obscura*, Ehrh.

Spores simple, ellipsoid, pale brown or yellow. Under the name *L. obscuroides* it is possible I have included two parasitic Fungi or Fungo-lichens—one on the type (*P. obscura*), and the other on its leprose condition.

Genus II.—Biatorina, *Mass.* Th. Fries, Arct., 185.

Species 1. *B. tuberculosa*, Th. Fr., Arct., 185; Spitsberg., 36.

On thallus of various *Peltideæ*, and of *Solorina crocea*.

Spores 8, fusiform, 2-locular, yellow, or colourless. Possesses spermogonia.

2. *B. Stereocaulorum*, Th. Fr., Arct. 188; Spitsb., 36.

On thallus or phyllocladia of *Stereocaulon tomentosum*, var *alpinum*, and *S. denudatum*.

Spores 8, oblong, 2-locular, colourless.

Genus III.—Buellia, *De Not.*, Th. Fries, Arct., 225.

Species 1. *B. urceolata*, Th. Fr., Arct., 233; Spitsb., 45.

Syn. *Leciographa*, Körb., Par., 464.
Lecidea parasitica, Smrf.

On thallus of *Verrucaria sphinctrinoides*, Nyl.; *Lecidea*

[1] "Observations on New Lichens and Fungi collected in Otago, New Zealand;" 'Trans. Royal Society of Edin.,' vol. xxiv, 1867.

obscurata, Smrf; *L. pezizoidea*, Ach.; *L. vernalis*, L., and other Lichens.

Var. *deminuta*, Th. Fr.

Syn. *Calicium turbinatum*, Smrf.

Lecidea parasitica, var., Th. Fries, Vet. Ak. Förh.

On thallus of *Lecidea cuprea*, Smrf.

Spores 8, oblong, 2—4-locular, brown.

2. *B. convexa*, Th. Fr., Arct., 234; Spitsb., 45.

Syn., *Leciographa*, Körb., Par., 464.

On saxicolous and frequently dead thallus of *Physcia cæsia*, *P. obscura*, *Placodium elegans*, and *Lecanora chlorophana*.

Spores 8, oblong, 4-locular, brown. In all probability this and the foregoing should be united with *Lecidea parasitica*, Flk.

Genus IV.—ABROTHALLUS, *De Not.*[1] Tul., 112; Linds., Hist. Brit. Lichens, p. 311; Monogr. Abrothallus, p. 7;[2] Mudd, 224; Mass., Rich., 88.

Species 1. *A. Smithii*, Tul., 115; Linds., N. Z. Lich. and Fungi, 447; Monogr. Abrothallus, 8; Hist. Brit. Lich., 312.

Syn. *A. Bertianus*, *A. Buellianus*, } De Not.; Mass., Rich., 88.

A. parasiticus, Nyl., Prod., 55.

A. pulverulentus, Anzi.

Parmelia saxatilis, v. *parasitica*, Sm.

P. conspersa, v. *abortiva*, Schær.

Bidtora Parmeliarum, Fw.

Lecidea, Smrf.

Endocarpon parasiticum, Ach.

Lichen parasiticus, Sm., E. Bot., t. 1866.

On thallus of *Parmelia saxatilis*, and var. *omphalodes*, *P. conspersa*, *P. caperata*, *P. physodes*, *P. tiliacea*, *P. sinuosa*, *P. olivacea*; *Sticta fuliginosa*, *S. sylvatica*, *S. limbata*; *Ricasolia pallida*; *Cetraria glauca*, *C. pinastri*, *C. Islandica*; *Physcia pulverulenta* (Anzi), *Evernia prunastri*, *Usuca barbata*.

Spores 6—8, soleaform, 2-locular, brown. Possesses pycnidia.

[1] Krempelhuber ('Lich. Fl. Bayerns,' 275) classes *Abrothallus* in the *Nesolechiæ* (q. v.).

[2] Lindsay, "Monograph of the Sub-genus *Abrothallus*," 'Quart. Journal of Microscopical Science,' 1857.

2. *A. microspermus*, Tul., 115; Hepp, 471; Linds., N. Z. Lich. and Fungi, 447; Monogr. Abroth., 8; Körb., Syst., 216.

Syn. *Lecidea thallicola*, Mass.

On thallus of *Parmelia caperata*.

Spores small, *colourless* or brown (Hepp); of same *form* as in preceding (Tul.).

3. *A. Welwitzschii*, Tul., 115; Linds., Monogr. Abroth., 8; Hist. Brit. Lich., 315; Körb., Par., 456; Hepp, 370 and 371; Leight., Exs., 191.

Syn. *Sticta fuliginosa*, v. *abortiva*, Schær.

Abrothallus Smithii, v. *pulverulenta*, Linds., Monogr. Abroth., 34.

On thallus or apothecia of *Sticta sylvatica* with its var. *Dufourii*, Dél.,[1] and *S. fuliginosa*.

Spores 6—8; otherwise as in *A. Smithii*, Tul. I refer both *microspermus* and *Welwitzschii*, as mere forms, to *A. Smithii*.[2]

4. *A. oxysporus*, Tul., 116; Hepp, 37; Mudd, 225; Linds., N. Z. Lich. and Fungi, 410; Monogr. Abroth., 30.

Syn. *Lecidea*, Nyl., Prod., 145.

Nesolechia, Körb.

Lichen ampullaceus, Wulf.

On thallus of *Parmelia saxatilis*, *P. conspersa*, *P. caperata*, *P. Borreri*, *P. sinuosa*, *Cetraria glauca*, *Evernia furfuracea*.

Spores simple, sometimes 2-locular or physcioid, ellipsoid, straight, sometimes curved,[3] colourless. Possesses spermogonia. The plant is apparently rare in Germany and Italy, as neither Körber nor Massalongo had met with it (*fide* Körb., Par., 462).

5. *A. Curreyi*, Linds., N. Z. Lich. and Fungi, 409.

On thallus of *Parmelia perforata*.

Spores 8, simple, ellipsoid, colourless.

6. *A. Moorei*, Linds., Observations on new Lichenicolous Micro-Fungi.

On *Cladonia bellidiflora*, Ach., Kelly's Green, Ireland.

Spores 8, ellipsoid, simple, colourless.

7. *A. Usneæ*, Rabenhorst, Exs., 537; Linds., N. Z. Lich. and Fungi, 444.

On thallus, cephalodia and apothecia, of *Usnea barbata*, vars. *florida*, *ceratina*, and *plicata*.

[1] Associated here sometimes with *Celidium Pelvetii* (*q. v.*), Hepp, 370.

[2] Linds., 'Monograph Abrothallus,' 8.

[3] Linds., "N. Z. Lichens," 'Trans. Linn. Society,' vol. xxv, p. 514.

Spores ellipsoid-oblong, soleaform (2-locular), brown. Apparently possesses pycnidia.

8. *A. Friesii*, Hepp, 464.

On thallus of *Verrucaria chlorotica*, Ach.

Spores very small, soleaform (2-locular), brown.

A. exilis, Flk., Hepp, 473; Mass., Rich., 88; and var. *macrospora*, Hepp, 473; is a *Lecidea*, with a proper thallus (Nyl., Prod., 136).

A. arthonioides, Mass., Rich., 89, is also apparently a *Lecidea* (Fée).

A. Ricasolii, Mass., Rich., 89; syn. *Buellia*, Körb., Par., 189; has also a proper thallus, and grows on tree-barks. It apparently includes (according to Körber) Massalongo's *A. arthonioides* and Fée's *Buellia arthonioides*.

Genus V.—Scutula, *Tul.*, 118. Linds., Hist. Brit. Lich., 316.

Species 1. *S. Wallrothii*, Tul., 119; Hepp, 135; Linds., Hist. Brit. Lich., 316.

Syn. *Peziza miliaris*, Wallr.
Biatora Heerii, Hepp, 135.
Biatorina, Anzi.
Lecidea anomala, Fr., var. *Wallrothii*, Nyl., Scand., 202.

On *Peltidea canina* and *P. rufescens*, Körb., Par., 454; on various *Peltideæ* and *Solorinæ*, Nyl., Scand.

Spores 6—8, small, ovate-ellipsoid, 2-locular, colourless. Possesses both spermogonia and pycnidia. A *Lichen* in so far as concerns the *blue* reaction of the hymenial elements with iodine. If this plant is to be referred to the *Lecideæ*, it will belong to that small section that possesses pycnidia in addition to spermogonia.[1]

2. *S. Krempelhuberi*, Körb., Par., 455.

On *Solorina saccata*.

Spores 8, very minute, ellipsoid, 2-locular, colourless.

3. *S. Stereocaulorum*, Anzi (Körb., Par., 455).

Syn. *Lecidea*, Anzi.

On thalline scales, or phyllocladia, ("thallus-schuppen") of *Stereocaulon tomentosum*, v. *alpinum*, and *S. fastigiatum* (Körb., Par.). But under the head *Stereocaulon*, in his 'Parerga,' Körber mentions neither a species nor variety *fastigiatum*; nor does he mention it in his 'Systema.'

Spores 8, small, acutely ellipsoid, 2-locular, colourless.

[1] *Vide* paper by the author on "Polymorphism in the Fructification of Lichens," 'Quart. Journal of Microscopical Science,' January, 1868.

Genus VI. — CELIDIUM, *Tul.*, Mém., 120. Linds., Hist Brit. Lichens, 317; N. Z. Lich. and Fungi, 448.

Species 1. *C. Stictarum*, Tul., 121; Hepp, 590; Linds., Hist. Brit. Lich., 317; N. Z. Lich. and Fungi, 451.

Syn. *Plectocarpon*, Fée.
Sphæria, De Not.
Lecanora parasitica, Auct.
Dothidea Lichenum, Smrf.
Biatora adligata, v. *involuta*, Fée.
Sticta pulmonacea, v. *pleurocarpa*, Ach.; Schær., Exs., 550.
Délisea, Fée.

On apothecia, thallus, or cephalodia of *Sticta pulmonaria*, *S. scrobiculata*, *S. Freycinetii*, and *Ricasolia corrosa* (Körb., Par., 456).

Spores 4 — 8, oblong or ellipsoid, 4-locular, pale yellow or colourless, sometimes becoming brown. Possesses spermogonia. Nylander (Prod. 52) refers it to the *Fungi*; though he points out its affinity to the *Arthoniæ* [e. g. *A. parasemoides* and *A. abrothallina*.

2. *C. fusco-purpureum*, Tul., Mém., 121.

Syn. *Spilodium*, Mass.

On *Peltidea canina*.

Spores 6—8, ovate-oblong, simple, colourless. Possesses spermogonia seated in the centre of the cluster of apothecia.

3. *C. varium*, Tul., Mém., 125. Körb., Par., 456.

Syn. *Phacopsis*, Tul.; Linds., Hist. Brit. Lich., 318.

On thallus and apothecia of *Physcia parietina*.

Spores 6—8, small, oblong, 4-locular, colourless, becoming brown.

4. *C. dubium*, Linds., N. Z. Lich. and Fungi, 449.

On sterile thallus of *Sticta granulata* and *S. rubella*; on sterile and fertile thallus of *S. fossulata*.

Spores unknown; apparently possesses spermogonia or pycnidia.

5. *C. Pelvetii*, Hepp, 372 and 589. Linds., N. Z. Lich. and Fungi, 450.

Syn. *Sticta aurata*, v. *abortiva*, Schær., Exs., 558.

On thallus of *Sticta aurata*.

Spores 8, soleaform (2-locular), pale yellow or colourless. It is, perhaps, this species that is referred to (but not named) in Hepp, 370, on *S. sylvatica*, v. *Dufourii*.

6. *C. furfuraceum*, Anzi.

On thallus of *Lecidea rhætica* (Hepp), *L. petræa*, and *Lecanora glaucoma*.

Tulasne (Mém., 125) mentions a *Celidium* as black-mottling *Placodium albescens* and *Squamaria saxicola*. Should this differ from the other so-called species, it may appropriately stand provisionally as—

C. squamariicolum.

C. muscigenum, Anzi, Symb. I have not seen Anzi's work, and do not know on what (if any) Lichen this species is parasitic. Nor do I know what is his *C. varians*, Dav. Körber, in his 'Parerga' (457), includes it in his *Celidium grumosum*, which is a synonym of *Arthonia varians*, Nyl. (*q. v.*).

Genus VII.—Conida, *Mass;* Körb., Par., 458.

Species 1. *C. clemens*, Tul., Mém., 124.

Syn. *Phacopsis*, Tul.
Arthonia, Th. Fr., Spitsb., 46.
Conida apotheciorum, Mass.
Sphæria, Mass.
Placodium Göppertianum, Körb., Par., 458.

On the apothecia of *Squamaria saxicola*, *S. chrysoleuca*, *Placodium albescens*, Hffm., and *P. murorum*, Hffm.

Spores 8, small, oblong, 2-locular, colourless. The parasite black-mottles the epithecium of *S. chrysoleuca*. Intermixed with the spermogonia of that *Squamaria*, on its thallus, other parasites occur, externally black (Nyl., Scand., 131). The ordinary spermogonia of *S. chrysoleuca* are described and figured in my "Memoir on the Spermogonia and Pycnidia of the Higher Lichens" ('Trans. Royal Society of Edinburgh,' vol. xxii, 1859, p. 260, pl. xv, figs. 15—17).

Genus VIII.—Phacopsis, *Tul.*, Mém., 124. Linds., Hist. Brit. Lich., 318; N. Z. Lich. and Fungi, 446.

Species 1. *P. vulpina*, Tul., Mém., 126. Hepp, 474; Linds., N. Z. Lich. and Fungi, 446.

Syn. *Evernia vulpina*, var., Fr.; Mass.

On thallus of *Evernia vulpina*.

Spores simple, oblong or ellipsoid, colourless.

2. *P. psoromoides*, Hepp, 475; Körb., Par., 459.

Syn. *Endocarpon*, Borr.; Mudd, 267.
Endopyrenium dædaleum, Krmp.
Dermatocarpon, Th. Fries, L. Arct. 255.

On *Lecanora mutabilis*, Ach. Mudd describes the spores

he found in Hepp's plant as simple and hyaline;[1] and the plant itself as referable to Borrer's *Endocarpon psoromoides*. The spores of the latter, as represented by Leighton (Brit. Angioc. Lichens, pl. ii, fig. 4), are 4-locular and brown; which spores Hepp refers to a parasitic *Sphæria* (*S. urceolata*, Schær. = *Xenosphæria Engeliana. (q. v.)*

In Hepp's plant I found two different forms of spore—the one colourless, becoming sometimes brown, 2-locular or simple; the other brown and 4-locular, becoming submuriform. The latter spores are doubtless referable to the parasitic *Xenosphæria*, whose perithecia are scarcely distinguishable from the associated, very minute, black, verrucarioid spermogonia, which are full of atomic, spherical spermatia. The hymenium of the *Xenosphæria* gives no blue reaction with iodine. The paraphyses are obscure, nor could I distinctly make out the thecæ. The spores of the *Phacopsis* resemble those of *Celidium Pelvetii*, being narrowly ellipsoid or fusiform, colourless, simple, becoming 2-locular in age, sometimes soleaform and brown, as in *Abrothallus Smithii*; the soleaform character being best developed under iodine; ·00045″ long and ·00015″ broad.

Genus IX.—Arthonia, *Ach.*, pr. p.

Species 1. *A. varians*, Dav. (Nyl., Scand., 260).

Syn. *A. glaucomaria*, Nyl., Prod., 168; Syn. *Arthon.*, 98. Leight., Ann. Nat. Hist., Oct., 1856; Exs. 247.
A. parasemoides, Nyl., Prod., 168; Mudd, 251.
Celidium grumosum, Körb., Par., 457.
„ *sordidum*, Anzi.
„ *varians*, Arnold.
Lecanora glaucoma, v. *varians*, Ach.
L. lainea, Ach.
L. rimata, v. *orbata*, Schær.
Biatora verrucarioides, Hepp.
Conida sordida, Mass.
Sphæria Lichenis sordidi, Mass., Rich., 4.

On apothecia and sometimes thallus of *Lecanora glaucoma*,[2] *L. subfusca*, and *Lecidea parasema* (Nyl., Scand.; and Prod., 168). On thallus of *Physcia parietina* and various *Lecanoræ* (Nyl., Prod.); on apothecia of *Lecanora cenisea*, Ach. (= var. *atrynea*, Ach., of *L. subfusca*), Mudd, in my herbarium

[1] Fries describes the sporidia as simple, hyaline, and endocarpoid.
[2] Associated sometimes with *Lecidea glaucomaria* (q. v.).

from Cleveland; on the soredia of *Isidium corallinum*, Ach. (Hardy).[1]

Spores 6—8, oblong, 2—4-locular, colourless. Possesses spermogonia. Th. Fries describes, without naming (Arct., 105), a parasite on the apothecia of *L. subfusca*, v. *lainea*, Ach., which has yellowish 2-locular spores, but which, nevertheless, may prove referable to *A. varians*.

2. *A. punctella*, Nyl. (Mudd, 252).

On thallus of *Lecidea albo-atra*; of *Lecanora erysibe*, Ach., Carroll, in my herbarium from Cork; and *Isidium corallinum* (Hardy).

Spores soleaform (2-locular), colourless.

3. *A. abrothallina*, Nyl.

I have met with no description of its characters. *A. calcicola*, Nyl. (Prod., 168), is apparently athalline; but not parasitic on other Lichens; a category to which belongs a considerable number of *varieties* of species that are usually possessed of a proper thallus.

Genus X.—Opegrapha, *Ach.*

Species 1. *O. Monspeliensis*, Nyl., Prod., 153.

On thallus of *Lecanora calcarea*.

Spores oblong, brown.

2. *O. anomea*, Nyl., Prod., 153.

On *Variolaria amara*, which is *Pertusaria communis*, v. *sorediata*, Fr., according to Nylander (Prod., 98).

Spores oblong, 4-locular, colourless.

Genus XI.—Sphinctrina, *Fr.* Mudd, 255. Nyl., Syn., 142 (whole genus parasitic).

Species 1.—*S. turbinata*, Pers. (Hepp, 326; Leight., Exs., 132; Mudd, Exs., 241; Schær, Exs., 6).

Syn. *Calicium*, Pers. Fungi.
C. sessile, Sm.
Cyphelium, Hepp, 326.
Sphæria sphinctérica, Sow. Fungi, t. 286; Moug. and Nestler, 366.
Lichen gelasinatus, With.

On thallus of various *Pertusariæ*, both saxicolous and corticolous; e. g. *P. communis* and *P. Wulfenii* (Nyl., Prod., 33; Syn., 143); sometimes of *Lecanora parella*, *Urceolaria scruposa*, and other crustaceous Lichens; of *Parmelia saxatilis*

[1] In letter of May, 1862.

and *Lecidea canescens* (near Chichester, communicated by W. C. Cooke in letter of May, 1866).

Spores 8, minute, spherical, simple, brown.

Var. *microcephala*, Nyl.; Mudd, 256.

Syn. *Sphinctrina microcephala*, Nyl., Prod., 34.
Calicium, Tul., Mém., 78.
Sphinctrina tubæformis, Körb., Syst., 305.
S. piniperda, Körb., Par., 288.
S. pinicola, Körb.
S. microscopica, Anzi.
Cyphelium, Hepp.

On thallus of *Pertusaria melaleuca*, Dub., and *P. communis* (Nyl., Prod., 34; Syn., 144). On young thallus of *P. Wulfenii*, Körb., Par. Associated, and apt to be confounded, with a parasitic *Fungus*, *Spilomium pertusariicolum*, Nyl. (Syn., 144; Enum., 91).

Körber (Parerga, 288) describes *S. microcephala*, Sm. (E. Bot., t. 1865), as having a proper thallus. According to Nylander (Prod., 34), the *Calicium microcephalum* of Smith (E. Bot., t. 1865) and Borrer (Lichenographia Britan., 130) is only a form of *S. turbinata*, and, therefore, = var. *microcephala*, as above. But Mudd (255) refers it to S. *anglica*, Nyl.

Several authors regarded *S. turbinata* and its varieties as *Fungi*, *e. g.* Persoon (Tent. Disp. Fung., Suppl., p. 59); M. C. Cooke, in his 'Index;' Sowerby, Mougeot and Nestler. Berkeley does so still (Brit. Fungology, 1860, p. 373); but Cooke wrote me, in 1866, "It has been included with *Fungi*, but I scarcely think it should rank with *them*." In a subsequent letter he says, more decidedly, "I do *not* think *Sphinctrina* should be associated with *Fungi*."

2. *S. anglica*, Nyl., Syn., 143; Mudd, 255.

Syn. *Calicium microcephalum*, Sm., E. Bot., t. 1865; Borr., Lich. Britan., 130.

Spores spherical, ellipsoid or oblong, simple and brown Mudd describes a proper thallus.

3. *S. fuscescens*, Nyl., Syn., 143.

Spores ellipsoid, brown. Cape of Good Hope.

4. *S. leucopoda*, Nyl., Syn., 144.

On thallus (perhaps) of *Pertusaria leioplaca*. Virginia, U. S.

Spores spherical, brown.

5. *S. gomphilloides*, Nyl., Syn., 144.

On thallus (perhaps) of *Pertusaria communis*; associated with a *Sirosiphon*.

Spores 8, oblong, 1-septate.

Genus XII.—Stenocybe, *Nyl.* Mudd, 256.

Species 1. *S. eusporum*, Nyl.
Syn. *Calicium*, Nyl., Prod., 32.
Stenocybe major, Nyl.
Sphinctrina septata, Leight., Exs., 228.
On thallus of *Thelotrema lepadinum* and *Graphis elegans*, but also with a proper thallus (Mudd, 256).
Spores large, oblong-fusiform, 2—4 locular, brown.

Genus XIII.—Calicium, *Pers.* Mudd, 256.

Species 1. *C. citrinum*, Leight.; Nyl., Syn., 149.
Syn. *Coniocybe*, Leight.
Cyphelium pulverariæ, Auersw.
On thallus of *Lecidea lucida* (Mudd, 261).
Spores oblong, simple or obscurely 2-locular, brown.
2. *C. paroicum*, Ach.; Nyl., Syn., 145.
Syn. *C. corynellum*, v. *Ach.*
C. chlorinum, Stenh.
On thallus of *Lecanora Hæmatomma* and its sterile condition *Lepraria chlorina*, Ach. (Nyl., Scand., 38).
Spores ellipsoid, simple, brown.
3. *C. disseminatum*, Fr.; Nyl., Prod., 28.
Syn. *C. microcephalum*, v. Fr.
Cyphelium, Ach.
C. atomarium, Ach.
Throughout France; only sometimes parasitic or athalline.
Spores simple, brown, oblong or spherical.

Genus XIV.—Trachylia, *Fr.*, pr. p. Nyl., Scand., 44.

Species 1. *T. stigonella*, Ach.; Nyl., Syn., 167.
Syn. *Calicium*, Fr.
C. inquinans, v. *sessile*, Schær.
C. sessile, Pers.
Cyphelium, Ach.
Acolium, De Not.
A. inquinans, v. *sessile*, Körb.
A. tympanellum v., Körb.
On thallus of various *Pertusariæ*—especially in their variolarioid condition, e. g. *P. communis*, *P. Wulfenii*, and *P. coccodes* (Nyl., Prod., 28; Syn., 167; Mudd, 254).
Spores 8, small, 2-locular, brown.

(*To be continued.*)

On the Structure *and* Relationships *of the* Simple *or* Nucleated, *and the* Compound *or* Punctate Forms *of* Thalassicollidæ. By John D. Macdonald, M.D., F.R.S., Staff Surgeon, R.N. (With Plate XI.)

Having perused Dr. Wallich's observations on the Thalassicollidæ in the 'Annals and Magazine of Natural History' for February, 1869, I was induced to review my notes upon this subject, reaching as far back as 1852, the year just subsequent to that in which Professor Huxley's excellent paper upon Thalassicolla was published; and though I can do little more than follow in his footsteps, yet the little material collected by me, as well as the accompanying figures (which are all original), may be acceptable to the students of the Protozoa. On the authority of Müller, one of the two forms of *Thalassicolla punctata*, described by Huxley with great accuracy, has received the name of Sphærozoum, originally applied to something ambiguously described by Meyen, while the other, or that with fenestrated capsules, has been named Collosphæra. It would seem, however, that *Thalassicolla nucleata* has escaped the criticism of the bibliographers, being retained as the nominal representative of the family. I shall at once proceed to the description of the figures, making such comments as may be suggested in passing.

Sphærozoum and Collosphæra.

Fig. 1. An example of Sphærozoum, taken in the towing-net off the Cape of Good Hope, natural size.

Fig. 2. Portion of the same, as seen with a quarter-inch power, but neither the central vacuolated portion, nor the external common gelatinous envelope, is represented. The structure of the puncta is simply as follows:—Beginning at the so-called nucleus, and proceeding outwards, we observe—first, (*a*) a bright yellowish, highly refracting, fatty globule; one, two, or more such globules being uniformly present in all the puncta of the same specimen, apparently in accordance with the stage of its development, and probably in some way connected with reproduction.

Secondly, (*b*), a mass of much smaller rounded, transparent, but not so highly refracting granules.

Thirdly, (*c*), a distinct cell-membrane investing the foregoing parts.

Fourthly, (*d*), a plastic exudation upon the surface of the

latter cell, in which the yellow granular bodies or sarcoblasts (*e*) are imbedded.

Fifthly, (*f*), radiating and branched filaments, and in fully formed specimens, a clearly defined pellicle (*g*) upon the surface of the plastic granular material, thus including the sarcoblasts. The pellicle here spoken of may possibly correspond with the tubulated or fenestrated membrane forming the nidus of siliceous deposit in Collosphæra, though we find it coexisting with a zone of simple or compound spicules in many examples of Sphærozoum, while such spicules never coexist with the siliceous capsules of Collosphæra. In other forms of Protozoa, however, both siliceous capsules and radiating spicules are present.

Fig 3 represents a specimen of Collosphæra of the natural size.

Fig. 4 gives the analysis of one of the puncta of Fig. 3, highly magnified, and taking the parts from without inwards.

(*a*) A perfect punctum.

(*b*) The fenestrated capsule.

(*c*) Animal cell-membrane surrounded by the yellow sarcoblasts.

(*d*) Purple granular and crystalline matter contained within the last-mentioned cell.

(*e*) Transparent, highly refracting, spherical globule, imbedded in the granular and crystalline matter, but, as also in the case of Sphærozoum, without distinct cell-membrane.

Fig. 5. Another example of Sphærozoum, natural size.

Fig. 6. The same considerably magnified to show the superficial distribution of the puncta between the central vacuolated substance and the gelatinous test.

Thalassicolla nucleata.

Fig. 7. *Thalassicolla nucleata,* natural size, with its transparent test and dark central spot.

Fig. 8. The same as seen with a low power, and exhibiting the following parts, from without inwards:

(*a*) The test.

(*b*) The vacuolated substance situated between the test and the nucleus.

(*c*) The sarcoblasts scattered amongst the roots of (*d*) the branched fibrous bands arising from (*e*) the external membrane of the central body, and here, like it, invested with black pigment granules.[1]

[1] Any cyclosis so called occurring amongst these granules has always appeared to me to be simple molecular motion, as in the choroid cells of the ox, &c.

(*f*) A zone of pale bluish, rounded granules, in the middle of which is (*g*) a well-defined cell-membrane, containing numerous salmon-coloured or yellowish fatty globules of uniform size (*h*).

Thalassicolla differs from Sphærozoum and Collosphæra in the nucleus being at least commonly multiglobular, with a distinct cell investment, while they differ from it in possessing a pellicle, cell, shell, or spicules, external to or including the sarcoblasts. We find points of resemblance in the external gelatinous test, the vacuolated matrix, peripheral in Thalassicolla, and central in the other forms; in the radiating branched fibres and the sarcoblasts, the cell-wall immediately surrounded by these last, and its granular contents. Moreover, the plastic matter in which the sarcoblasts are imbedded in Sphærozoum may represent the dark pigment of *Thalassicolla nucleata*.

Though these simple forms of animal life may be stated to possess a nucleus, yet does this nucleus not only differ considerably in the two leading types above described, but it would appear to hold no relation to the nucleus of Amœba, or the other better known Protozoa.

As to the question of the simple or compound nature of the punctate forms, Dr. Wallich states that "isolated free floating individuals of the Sphærozoum and Collosphæra type are constantly to be met with," and are to be found "not only as free floating organisms, but also within the digestive cavities of Hydrozoa, of far too minute size to have been able to swallow them in the aggregate state;" but anybody acquainted with the filmy and destructible nature of the connecting substance in some specimens would doubt much that those "free floating individuals" were not detached from a normally composite mass. My own experience quite accords with that of Dr. Wallich above quoted, but I must say that it would not warrant me to arrive at the same conclusion. I rather incline to the belief that at least one mode of increase is by fission, as indicated by the dumb-bell-like, and moniliform character of the masses, so frequently observed. I have only to add to these remarks, that I have repeatedly seen *Thalassicolla nucleata* give out a phosphorescent light on being irritated or pressed between two slips of glass; any argument, therefore, founded upon the assumed absence of this phosphorescence cannot be sound.

On New Forms *of* Diatomaceæ *from* Dredgings *off the* Arran Islands, County Galway. By the Rev. Eugene O'Meara. Third Series.

(With Plate XII.)

The forms from the Arran material referred to in this my third paper on the subject have already, from time to time, been exhibited at the meetings of the Dublin Microscopical Club, so that nothing remains to be done respecting them except to add the minute details of description.

Pleurosigma giganteum, Grun., var. *baccatum* (Pl. XII, fig. 1).—I give the general description of *P. giganteum*, by Grunow, as the best introduction to the peculiarity of this variety. "A very large Pleurosigma; on the secondary side lanceolate, with obtuse apices, nearly straight; median line slightly sigmoid; striæ transverse, fine, 50—55″ in 0·001″; longitudinal striæ somewhat finer and more remote; decussate lines extremely fine, more than 70 in 0·001″; colour in the dry frustule pale yellowish; length, 0·0110″—0·0170″, breadth 0·0016″—0·0022″. A very well distinguished species; I know no other that can be confounded with this fine Pleurosigma. The delicate structure and uncommon size, as well as the nearly straight figure, distinguish it from all others." Grunow—'Ueber neue oder ungenügend gekante Algen; Verhandlungen der Kaiserlich-Koniglichen Zoologisch-botanischen Geselschaft in Wien,' Band x, p. 559.

The foregoing description of *P. giganteum* agrees with that of the form now under consideration in all respects except that the decussate lines referred to have not been noticed. The distinguishing characteristic of this variety is a chain of bead-like dots which adorns the outward margin as well as both sides of the median line.

Plagiogramma costatum (fig. 2), n. s.—Valve sublinear, slightly inflated in the centre; length 0·0034″, breadth 0·0009″; apices cuneate; vittæ, two central and one at either end; striæ costate, pervious. The forms of this genus hitherto described are represented as having moniliform striæ. Greville, in his paper on the genus *Plagiogramma*, 'J. M. S.', 1859, 207, remarks—"The species are furnished in almost every instance with conspicuous moniliform striæ. There is, however, in *P. ornatum* an approach towards the costæ of Odontidium." Further on (p. 209), the striæ of the last-named species are described as *moniliform-costate*. Ralfs, in Pritchard's, 'Infusoria' (p. 774), includes the moniliform

striæ among the characteristics of the genus; his words are, "moniliform, generally interrupted striæ."

The present form, which occurred not unfrequently in the Arran material, stands distinguished from the species hitherto described by its plainly costate striæ.

Grunow has described a species named *Grevillianum*, "striis transversis tenuibus," which in this particular approaches *P. costatum*, but in outline, as well as by the fact of having but two central vittæ, is manifestly distinct from the present form.

Melosira Wrightii (fig. 3), n. s.—Diameter ·0016″. The front view exhibits the appearance of a crown; the sides, rising from the lower margin, curve slightly outwards, and after a little bending inwards and then downwards form a broad circular rim around a central depressed space, in which latter are two distinct nodules. The valve is perfectly hyaline, and without sculpture of any sort. Several forms of this species occurred exhibiting the side view, I considered them to be *Melosira Westii*, until I was fortunate enough to procure a front view, when I was convinced that they belong to a different species.

Pinnularia marginata (fig. 4), n. s.—Valve elliptico-linear, very slightly constricted in the middle; length 0·0018, breadth 0·0008; striæ costale, submarginal, with a tolerably broad span between their inner termination and the median line; the median space bounded by double lines, which spring at either side from the angles of the central nodule, and curving gently outwards for about half their length bend inwards and meet in a sharp angle at the terminal nodule.

Pinnularia scutellum (fig. 5), n. s.—Valve broadly elliptical; length 0·0027, breadth 0·0020; striæ costate, radiating towards the apices, leaving a narrow submarginal space, not reaching the median line; central nodule large; the median space large, lenticular, ornamented with a row of minute dots close to the outside of the boundary line.

Amphiprora costata (fig. 6), n. s.—Valve elliptical, much constricted in the middle; length 0·0064, breadth at widest part 0·0019, at the constriction, 0·0009. The keel costate; costæ slightly radiating towards the apices, very short at first, gradually increasing in length for about one eighth the length of the entire frustule, then gradually decreasing till they disappear, about one eighth of the entire length of the valve from the central constriction.

Facts *bearing on the* Structure *and* Arrangement *of a* Nervous Mechanism *demonstrated in the* Auricle *of the* Frog's Heart.

By Lionel S. Beale, M.B., F.R.S.; Fellow of the Royal College of Physicians; Physician to King's College Hospital; Professor of Physiology in King's College, London. With Plate XIII.

The rhythmic contractions of a portion of the muscular tissue of the heart continue for some time after it has been severed from the rest of the organ and removed from the body. A closely allied fact is observed in the case of the muscular coat of the intestinal canal; and in some muscles of insect larvæ, which have been removed from the body with due care, the muscular tissue continues to contract for some time after its removal. The muscles of the common maggot will retain their contractility for an hour or more after they have been placed upon a glass slide ("Croonian Lecture," 'Proceedings of Royal Society,' May 11, 1865, p. 229).

In all these instances careful observation will prove, not only that nerves have been removed with the contracting tissue, but that nerve-ganglia, or nerve-ganglion-cells, the centres with which the nerves are connected, are intact. The movements observed may, therefore, be dependent upon the action of the ganglion-cells. Pieces of muscle entirely separated from the nerve-cells cease to contract very soon after their removal, while, as is well known, if pieces of the ventricle of the heart of a frog, in which ganglia are known to be situated, be removed, *rhythmic contractions* continue to take place for some time, but if those parts of the ventricle which are destitute of ganglia be selected, the incisions made are sufficient to stop rhythmic movements.

If, then, we could demonstrate the distribution and arrangement of the nerves amongst the muscular fibres of the heart, and trace them to and from the ganglion-cells with which they are connected, we might, perhaps, be able to form some notion of the general arrangement of the nervous mechanism concerned in reflex movements; and the conclusions arrived at might be of the greatest assistance in enabling us to trace out the changes which are essential to the simplest kinds of nervous action.

The inquiry is, however, one of great practical difficulty, since it would be useless to attempt to follow a nerve, or even a bundle of nerves in their ramifications amongst the mus-

cular fibres of the ventricle of the smallest and thinnest heart. They change the planes in which they ramify so continually that, in preparing sections thin enough for observation, we should inevitably fail to trace the same fibre, even for the distance of the $\frac{1}{500}$th of an inch. In the thinnest part of the auricle, however, we have an extended section already made for us; and in the hyla this is so very thin that there is but a single layer of muscular fibres, and I have succeeded in tracing the nerves amongst the delicate ramifications of the reticulated muscular tissue for a considerable distance. See Pl. XIII, fig. 1.

Distribution of the nerves to the muscular fibres.—In this beautiful texture the finest branches of nerves are seen to form networks amongst the muscular fibres. No end-organs or end-plates of any kind are to be detected anywhere; but so fine are the fibres, and so separated from one another, that if such organs existed they could hardly escape observation, more especially as we find, very clearly demonstrated, nerve-fibres very much finer than those connected with the so-called end-organs in other situations; nor does the nerve-fibre penetrate the sarcolemma, for in these muscular fibres this structure is absent. Bundles of fine, pale, "nucleated" nerve-fibres are seen ramifying amongst the muscular fibres, and dividing into finer and still finer branches, the finest being less than $\frac{1}{100000}$th of an inch in diameter, but these can, nevertheless, be followed for long distances. The masses of germinal matter of the nerves (nuclei) are often situated very close to the muscular fibres, as in the lower part of fig. 2, to the right; but they can, nevertheless, be seen to be connected with the nerve-fibres only, and not with the muscular tissue.

The nerve-cells.—The only nerve-cells in the cardiac ganglia are the oval or pyriform cells I have fully described elsewhere. Some have but two fibres, but many have five or six, or even more, which may run parallel to or be curled spirally round one another for a short distance from the cell; but they do not run far before they pursue opposite directions as they pass from the cell with which they are connected. I have preparations of the thin part of the auricle of the frog's heart, in which fibres can be seen to leave the ganglion-cells and be followed for some distance to their ultimate distribution upon the muscular fibres.

Fig. 1.—I have figured a single ganglion-cell with its straight and spiral fibres. I have not, indeed, succeeded in tracing a nerve-fibre from the cell to its peripheral distribution and back again to the same cell; but at the same

time it will be admitted that, at least in this instance, we have some very definite data to argue from.

In the tissue I have figured there are no capillary vessels; only one kind of nerve-fibres; only one nerve-centre; connective tissue between the muscular fibres, in which very fine nerve-fibres can be followed; no sarcolemma to confuse us; very fine muscular fibres, some less than the $\frac{1}{1000}$th of an inch in diameter, over and under which the nerves can be seen to pass; and lastly, masses of germinal matter belonging to (*a*) the muscular tissue, (*b*) the nerves, and (*c*) the connective tissue. Moreover, these tissues form together a very thin expansion, one surface of which, during life, is in contact with the blood, while the other is free within the pericardial cavity.

The facts ascertained by a careful examination of the specimens almost compel us to infer that the fibres leaving each nerve-cell are *afferent* and *efferent*. And it is really not venturing far beyond the conclusion to which direct observation leads us if we conclude that a nerve-fibre leaves a nerve-cell, and, after ramifying amongst muscular fibres, passes near to the inner surface of the auricle, and then returns to the same cell. An impression made upon the last part of the fibre, as from the mere stretching to which it would be subjected by the dilatation of the auricle with blood, or by the blood itself affecting the current traversing it, would cause momentary change in the cell, and an augmentation of the intensity of the current sufficient to cause sudden contraction of the muscular fibres. The changes which caused the contraction ceasing, the muscular fibres would again be relaxed, after which more blood would be poured into the cavity, and the distension of its walls would bring about a repetition of the same phenomena as before, which would be immediately followed by contraction, and so on.

The *spherical and oval ganglion-cells*, as distinguished from the *angular and caudate nerve-cells*, are sufficient for the production of reflex action. This class of cells is the only one that exists in the invertebrata where reflex actions are remarkable. These cells are highly developed in the lower vertebrata, and are well formed and active in mammalia and man at a period of development when the angular and caudate cells are still in an embryonic and incomplete state, and, as yet, incapable of performing any office or work.

NOTES AND CORRESPONDENCE.

The Royal Microscopical Society.—We have received two circulars relative to a change which is about to be made in the mode of publishing the 'Transactions' of the above Society. It appears that in future they are no longer to be published under the auspices of the Society in the well-known 'Quarterly Journal of Microscopical Science,' edited by Dr. Lankenster and his son, but in a new monthly journal to be issued by Mr. Hardwicke, and edited by Dr. Lawson. We shall be glad to see both these journals thrive. Of the continued success of the old Journal we have no doubt, more especially as the wholesome competition about to be created will stimulate editors and publishers. Of the new one we can, of course, say nothing at present. Our object in referring to this circumstance is, however, not so much to direct the attention of microscopical observers to it, as to express the opinion that a Society which has been at the trouble and expense of obtaining a Royal Charter of incorporation, and which has changed its members into "fellows," should publish its own transactions independently of any periodical, however respectable and useful it may be. Whilst the Society was content to pursue its labours unostentateously, and when all the members were charged the moderate annual subscription of a guinea, the publication of its transactions in some periodical was justifiable, but after the changes which have been made (whether they were proper or not is a matter of taste), we think it hardly consistent that the transactions should serve as a shuttlecock for rival publishers. If our anticipations should not be fulfilled, and it should be found that the circle of microscopical readers is not sufficiently extended to support a second journal, then the members will have to be referred back to the old Journal, or to some new literary *protégé* of the council, and any one desirous of binding the 'Proceedings' continuously, and placing them for reference upon his shelves, must take with them whatever

may appear in the journal in which they have been published. But there is even a more serious objection than this. Recent events elsewhere have shown that connections of this kind are not conducive to good feeling amongst the members of the council of a learned society, and we should indeed be sorry to see dissatisfaction arise in this one, which might necessitate a "Committee of Inquiry," accompanied, as such proceedings usually are, by all the amenities of a scientific controversy. We have no desire to place any obstruction in the way of the council, but it is obviously our duty to mention these matters before the trouble has arisen. It appears to us that they have made more than one mistake. The charter of incorporation and change of names has in nowise elevated the Society or its members, but has entailed an expenditure which has not alone necessitated an increased subscription to new members (a double tariff, in fact), but has so reduced the funds as to render it a matter of difficulty to pay the postage on the 'Transactions.' The publication of those in the old Journal a day longer than was necessary was another mistake; the transference to a rival, a third. The Council should charge all members alike, publish their own 'Transactions,' and limit their moral responsibility to the record of what passes at their meetings. If these hints pass unheeded now, the time will come when they will be remembered.—*The Quarterly Journal of Science.*

New "White-Cloud" Lamp Shade.—I have for a long time experienced a want, in which, I think, most workers with the microscope will sympathise with me—that of a really good and efficient shade for the lamp.

That the shades now commonly in use are far from fulfilling the required conditions will, I think, be readily conceded. The old conical paper shade is a very primitive contrivance; it does not sufficiently exclude the light, soon gets scorched, dirty, and misshapen, and is, besides, clumsy and awkward to adopt in many instances.

The so-called "Fiddian" metallic chimney, although a step in advance of the paper shade, still has several serious defects. Unlike the conical shade, it shuts out *too much* light, throwing the table into such deep shadow that it becomes necessary to have another lamp in order to find one's slides or accessories; moreover, this shadow, being deepest immediately around the base of the lamp, it is impossible to throw the light downwards on to the mirror without tilting it forwards, a manifest objection with a paraffin lamp, to which alone is the metallic chimney applicable.

Then, again, the white lining is always chipping off and is troublesome to replace, by an amateur especially; considerable heat is radiated from its bright metal sides; and, finally, the cost, although not much in itself, when added on to the price of a lamp, makes the total amount to a considerable sum.

These considerations led me to try some experiments, which have resulted in the production of a shade so satisfactory, not only to myself, but also to those of my friends to whom it has been shown, that I am induced to send a description of it to the 'Quarterly Journal,' thinking it might be of interest to some of its readers.

The shade consists of a short cylinder made of unglazed earthenware, coloured black on the outside and for about an inch from the top on the inside, the rest of the inside being left white. It is of such a size as will just allow of its passing over the chimney of the lamp, about two or two and a half inches in diameter and about four inches in length. On one side of this cylinder an opening is made about two inches long by an inch in width. The cylinder is to be passed over the chimney of the lamp, and may be supported either by three projecting arms carried by the burner or, what is perhaps better, it may be attached in the manner shown in the figure (which shows the shade fitted to a travelling lamp, drawn to a scale of one quarter), to a short cylinder which is capable of sliding up and down upon a tube carrying the lamp.

The chief advantages of these shades are these:

It is easily adopted to any form of lamp, whether oil, paraffin, camphine, or gas.

It takes up very little space, and is therefore particularly applicable to travelling lamps.

Being open at the bottom, it casts no downward shadow whatever, so that the light can be readily thrown upon the mirror without the necessity for tipping the lamp forwards.

The material and colour of the shade effectually prevent the radiation of heat, whilst the pure "dead" white of the inside gives a most perfect "white-cloud" illumination.

It is readily raised, lowered, or, if thought desirable, removed altogether from the lamp.

It can be made cheaply. Mr. Baker, of High Holborn, is taking steps to produce this shade, and will, I have no doubt, be able to supply it at a trifling cost.—HENRY F. HAILES.

Dr. Woodward's Paper in the October Number.—Mr. Glaisher, in his late address to the Microscopical Society, states that Dr. Woodward's paper on Roberts' test-plate was published in the Journal without acknowledgment of its having been sent for publication by the Society. This is very true, because it was not sent for publication by the Society, but was published by Dr. Woodward's special request in the forthcoming number of the Journal.

Snow Crystals.—A Mr. Charles Belcher, of Bedford, has made the startling discovery (!) that snow consists of crystals, and has written a letter on the subject to the 'Times.' The leading journal, with its characteristic appreciation of scientific fact, publishes the astounding announcement (!) Is not this a powerful argument in favour of science-teaching in our schools?—*Scientific Opinion.*

The Fauna of the Gulf Stream at Great Depths.—The investigations ordered by the new Superintendent of the Coast Survey, Professor Pierce, of Harvard College, into the marine fauna of the Gulf Stream, in connection with the regular duties of the survey, have begun to produce their natural result, in such valuable contributions to science as we have now before us. The line of the present survey was "in a section between Key West and Havana, incidentally with the purpose of sounding out the line for the telegraph cable." Although the work was interrupted, and the casts made with the dredge few, "the interesting fact was disclosed that animal life exists at great depths, in as great a diversity and as great an abundance as in shallow water." By two casts in 270 fathoms off Havana, crustacea and worms, numerous dead shells of gasteropods and pteropods, living terebratulæ, and seven species of bryozoa, besides echini, starfishes, and an abundance of corals, hydroids, and foraminiferæ, were taken. Only one species of seaweed, however, was mixed with this luxuriant animal life, which corresponds with similar results of deep-sea dredging in the European seas, and shows that "the greater number of deep-sea animals must be carnivorous." They found, also, that a porous limestone was in process of formation, "composed

apparently of the remains of the same animals which were found living." In a cast made in 350 fathoms nothing was brought up but a few dead corals. "The echinoderms appear to have a wide distribution in depths," and the gorgonias (sea-fans) are represented in 270 fathoms, by at least two species known to belong to the West Indian fauna, in moderate depths. The results of this attempt are certainly very interesting and important to marine zoology, although no casts were made in the deepest parts of the channel.

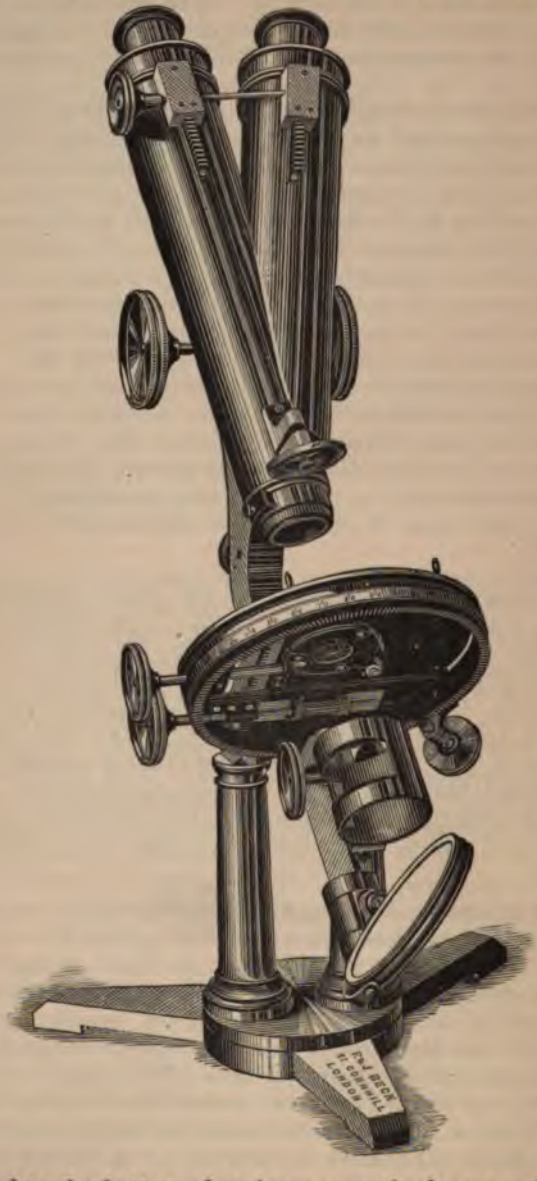
With our present knowledge it is premature to assume the existence of the higher forms of animal life in the profound abysses of the Atlantic and Pacific Oceans, but dredging in the Gulf of Mexico may be carried to such a depth as to have a most important, if not decisive, bearing upon this question, since the Coast Survey have sounded over 9000 feet in one instance, and several times to the extent of 6000 feet.

Dredging has been very recently carried on at enormous depths by the Scandinavian expedition to Spitzbergen; for it is stated, in the November number of the 'Annals and Magazine of Natural History,' that Messrs. Malmgren and Smitt have dredged up a variety of animals from a depth of 2000 feet, near Spitzbergen. — *American Naturalist*, January.

Microscopy in Russia.—Some of the papers published in German and French as well as in the Russian language in the 'Memoirs of the Imperial Academy of Sciences of St. Petersburg' are exceedingly valuable and beautifully illustrated. M. Owsjannikow has sent us some memoirs published by him within the last few years; one, "On the Structure of the Ear in the Lamprey," is exceedingly good, as also that "On the Auditory Organ in *Cephalopoda*." The important papers of Kowalewsky "On the Development of Amphioxus" and on other subjects appear in the academy's memoirs.

Beck's Concentric Rotating Stage. — The main object of this stage is to afford the means of giving a concentric rotation to the object in the field of view of the microscope; this is accomplished in the following manner: — The stage is fitted into a strong ring, which is firmly attached to the limb of the microscope, and is moved round by a rack-and-pinion adjustment, or, if a quick movement is desired, on pulling out the milled head as far as the stop will allow, a rapid rotation of the stage can be made with the hand. The top stage-plate has two sliding rests for clamping an object, and a movable hinged arm is fitted to

the lower rest as a stop for Maltwood's finder. The stage underneath is fitted with Brown's iris diaphragm, which is



attached to the bottom plate by means of a lever, and which,

when not required, can be turned on one side, where it is quite out of the way of any apparatus which may be required in the supplementary body. The ring in which the whole of the stage rotates is divided into degrees on the edge, and serves the purpose of a goniometer.—R. and J. Beck.

A Microscopic Cause of Death.—At a recent meeting of the New York Pathological Society Dr. Neptet called attention to a state of the brain causing sudden death in infants. After stating the particulars of a case, he said—"In such cases the microscope alone can reveal the real cause of death, and show the enormous changes which have taken place, especially in the white substance of the brain, as can be seen in any microscopical section taken from this specimen. We find accumulations of granule-cells or granule-globules lately described by Virchow, for the explanation of which I must say a few words with regard to the whole pathological process. Formerly the brain and spinal cord were considered as consisting of nothing else but specific nervous elements—ganglionic-cells and nerve-fibres. Afterwards Purkinje and Valentin described the epithelium of the ventricles under the name of *ependyma*, but Virchow, in 1853, showed that, besides the nervous elements, there are others belonging to the connective tissue group, which he named *neuroglia*. He showed, moreover, that in the nervous centres, just the same as in every other organ, we must make a distinction between pathological processes affecting the specific elements (parenchymatous processes) and those taking place principally in the interstitial connective tissue (interstitial processes). For instance, what the French call *ramollissement jaune* (yellow softening of the brain) is nothing else but fatty degeneration of the cells of the neuroglia, but not of the ganglionic cells. In cases of stillborn children, or of many of those who died in the early period of life, we find the cellular elements of the neuroglia increased in size (hypertrophy), then increased in number (hyperplasy), and finally undergoing fatty degeneration, so that, instead of single cells of the neuroglia, we find in these cases accumulations of granule-cells or granule-globules. In fact, we have interstitial encephalitis and interstitial myelitis, which explains the cause of death. Virchow found such diffuse interstitial encephalitis and myelitis in the infant, either accompanying constitutional syphilis of the parents or the acute exanthemata, especially smallpox of the mother, puerperal and other constitutional disturbances of the mother. He thinks that in those cases where the infants do not die this condition of the nervous centres may possibly be

the starting-point for subsequent idiocy or infantile paralysis. Graefe has lately described a peculiar sloughing of the cornea of both eyes in infants, where at the post-mortem such a diffuse interstitial encephalitis has been found by Cohnheim and Hirschberg.—*The Medical Record*, Dec. 1st, 1868.

Surirella Capronii, *Kitton*.—This is a new species of Surirella recently described by Mr. F. Kitton from specimens found by Dr. E. Capron, at Shere, near Guildford, and by M. de Brébisson at Falaise, Normandy. Its peculiarity consists chiefly in one or two horn-like processes which project from the longitudinal median line.

Lichen Zoospores.—In the 'Annales des Sciences Naturelles,' vol. viii, MM. Famintzin and Boranetzky give the results of their experiments on the gonidia of Lichens, and the transformation of their contents into zoospores. The common yellow Lichen, *Physcia parietina*, was the species employed. The thallus was for many weeks subjected to continual moisture until decomposed, and the conidia isolated. The conidia thus obtained were washed and deposited on pieces of lime bark. The changes they underwent were precisely those which M. Nageli describes in a species of Cystococcus, which our authors consider to be nothing more than Lichen-conidia in transformation. A portion of the conidia had their contents changed into zoospores, the rest passed through the stages of cell division and fissuration. The zoospores are elongated and narrowed at one extremity, which is furnished with two vibratile cilia. The period varied from four to six weeks from the time of commencing the disintegration of the thallus to the development of zoospores. The presence of zoospores in Algæ has long been demonstrated; more recently they were detected in Fungi; and now, at least, three genera of Lichens, viz. Physcia, Evernia, and Cladonia, are shown to possess them. An examination of the conidia of Peltigera has led our authors to the conclusion that they are identical with an Alga (Polycoccus), and that those of Collema develop into organisms similar to Nostoc.

A New Microscope.—The Messrs. Solomons, of Marlborough Street, have produced a microscope with two object-glasses—one, a 1 in. English, the other a ¼ in., of German make, with slow and fine adjustments, condenser on stand, live-box, &c., packed in a mahogany stand. It is sold at a low price, and appears to be well adapted for students and amateur microscopists.

REVIEWS.

The Anatomical Memoirs of John Goodsir, F.R.S., edited by W. Turner, M.D. With a Biographical Memoir by Henry Lonsdale, M.D. Two vols. Edinburgh: Adam and Charles Black.

THE name of John Goodsir is not, perhaps, so familiar to microscopical observers as that of many others who have done less service to science by the aid of the microscope. The fact is, the late Professor in Anatomy prosecuted his researches in anatomy and physiology from a very exalted point of view, and the microscope was only used by him, as it always ought to be used, as a means of observation subservient to the higher generalizations of biological science. At the same time these memoirs abundantly show that the microscope was one of the most frequent instruments employed in his anatomical and physiological researches. One of the earliest memoirs in these volumes is that on "The Development of the Pulps and Sacs of the Human Teeth;" and although not an exclusively microscopical subject, he could not have carried on his researches on this subject or have arrived at his conclusions without the aid of the microscope.

It is not, however, for researches with the microscope upon special subjects that Goodsir's memoirs have a claim upon the attention of microscopical observers; but for his papers and lectures he may justly be said to be one of that great school of observers, with Schleiden and Schwann at their head, who have changed the whole face of physiological and anatomical science by their discoveries of the nature of the cell and its functions by the aid of the microscope.

The position of Goodsir in relation to the great movement which took place after the publication of Schleiden's paper on phytogenesis in 1838 is so well described by Dr. Lonsdale in his biographical sketch that we venture to introduce rather a long passage for the benefit of our readers:

"Like all the early observers of 'the cell,' Dr. Goodsir met with difficulties. Granted a cell, with its walls, its contents, its nucleus and nucleolus, what then? Did the formation of cells depend on an endogenous or exogenous growth, a fissiparous division, or a gemmiferous thrusting forth of new cells or materials? Theory often ran in advance of observation, and Goodsir, too anxious for a foremost place in the race of competition, went boldly onwards; for, with too many of that period, instead of comparing microscopic observation with the data furnished by the test-tube and the philosophical balance, the desire was to be able to cry 'Eureka!' before your neighbour. This mode of procedure could excite no surprise; histology was an almost untrodden field, the explorers of which were enthusiastic and impressionable. The new developmental anatomy attracted *dilettanti* and idealists, as well as the legitimists in science, and came to be viewed in the highest light as an Archimedean lever to the biological world—a consummation devoutly to be wished by the physicist, physiologist, and positivist, all of whom took part in the discussion of a subject that seemed specially to concern the anatomist alone. The geometrician saw the fundamental form of nature represented in the cell—a hollow spheroid or ellipsoid; the physiologist would have it that all the processes engaged in the vital functions rest upon a combination, recombination, or multiplication of cells; and Comte, rising with his philosophy still higher, found in the life of the single cell a type and the source of not only the functions of individual man, but also of the *grand être*—humanity. Even the lover of the æsthetical, struck by the histological elements, both in their origin and coalesced functions, glorified them into a form of beauty charmingly consonant with his *beau ideal* of life, and his higher aspirations towards the primitive æsthetic standard. Goodsir, no less speculative than scientific, was not the least conspicuous supporter of the new doctrines that bid fair, at one time, to make the cell the whole science of life.

"Of the lectures delivered in the theatre of the Royal College of Surgeons in the summer of 1842 and winter of 1842-43, a portion was devoted to the consideration of practical subjects—*ex. gr.* surgical pathology; another portion embraced anatomical and physiological questions of current or rather special interest to the younger members of his audience, and were afterwards woven into a work—'Anatomical and Pathological Observations,' (*vide* vol. ii, p. 387). The prominent doctrines enunciated by Goodsir in these lectures mainly rested on the existence of centres of force connected with the nutritive and reproductive changes in the normal and pathological processes. The term 'centres of nutrition,' or 'germinal centres,' as employed by him, obviously possessed a similar signification to that which at this time is attached by Dr. Beale to his 'germinal matter,' and by various anatomists of the most modern German school to their masses of nucleated protoplasm. The allocation to these definite 'centres,' not only of the forces engaged in the nutrition of the textures, but in the reproduction of new forms both in normal and pathological processes—a doctrine which has been in its special relations to pathology so systematically pursued by Virchow and his disciples—was unmistakably present in the mind of Goodsir, and also articulately expressed in the pathological papers in the series now referred to. This, it must be remembered, was at a period when the origin of new cell-forms by a process of precipitation, or molecular aggregation in a fluid blastema or exudation, was the doctrine prevalent in the schools.

"Of the part which the nucleated cell plays in the processes of nutrition, secretion, and reproduction, normal and otherwise, it may perhaps suffice to refer the reader to the paper on 'Centres of Nutrition,' to that

on 'Absorption and Ulceration, and the structures engaged in these Processes,' and On the Process of Ulceration in Articular Cartilages;' to the memoir on 'Secreting Structures,' and the short essays on the 'Structure and Economy of Bone,' and on the 'Mode of Reproduction after the Death of the Shaft of a Long Bone.' Corroborative evidence may also be met with in his memoir 'On Diseased Conditions of the Intestinal Glands,' and the paper on the 'Structure and Pathology of the Kidney and Liver.' In these various essays the presence of the products of secretion within cells; the increase which takes place in the size of the cells, and the multiplication of their nuclei when influenced by morbid changes; the rupture of these enlarged proliferating cells, and the discharge of their nucleated contents; the destruction, scooping out, and solution of textures by the action of the forces residing in these new formed structures; the presence of soft nucleated masses in the lacunæ and Haversian canals of bone, and the part which they play in the absorption of bone; and the changes which take place in nucleated cells in connection with cyst-formation—all testify to the largeness of his observation of cell-life, both physiologically and pathologically.

"In the first of these memoirs not only does he advocate the importance of the cell as a centre of nutrition, but argues that the organism is subdivided into a number of departments, 'each containing a certain number of simple or developed cells, all of which hold certain relations to one central or capital cell around which they are grouped.' This idea has since been freely made use of by Professor Virchow, though, it must be admitted, without a due acknowledgment of the quarter in which it was originally stated, and it has obviously influenced many of his physiological and pathological speculations. This reticence is the more strange, as Virchow dedicated his work on *Cellular Pathologie* to the Edinburgh professor in the following complimentary terms:—'To John Goodsir, F.R.S., &c., as one of the earliest and most acute observers of cell-life, both physiological and pathological, this work on Cellular Pathology is dedicated, as a slight testimony of his deep respect and sincere admiration, by the author.' As Professor Virchow has travelled over much of the ground that had been previously cultivated by Goodsir, it is no less remarkable than disappointing to find in Virchow's volume of 433 pages but one reference to Goodsir, and that in connection with an observation the merit of which might be more fairly ascribed to Dr. Martin Barry. This is scanty civility to a scientific *confrère* whom he has called 'one of the most acute observers of cell-life'—one whose labours he has availed himself of, and whose opinions and words he has occasionally adopted.

"In his paper on the 'Morbid Changes affecting the Glandulæ Aggregatæ of the Ileum in Fever,' Goodsir (vol. ii, p. 377) describes these changes to be of the following nature—viz., 'the development of cells within the constituent vesicles of the patches to such an extent as at last to burst them, or cause their solution; the continued increase in the number of the cells proceeding from as many centres as there are vesicles in the path; the conglomeration of the whole into one mass above the submucous and under the mucous membrane, the distension of the latter, and the necessary ulceration and sloughing of the mass arising from this circumstance.' This is clearly Virchow's 'proliferation of cells.' Then, in p. 390 of the same volume, Goodsir, speaking of simple or developed cells holding certain relations to one central or capital cell, says—'It would appear that from this central cell all the other cells of its department derive their origin. It is the mother of all *within its own territory*.' If the reader will be at the pains to compare the whole paragraph from which this passage has been quoted with a paragraph at p. 14 of Mr.

Chance's translation of Virchow, that terminates with the word '*cell-territory*' (zellen-territorien), he cannot fail to see the close following or copying of Goodsir. Virchow, however, makes no reference to the source from which he has obtained his cell-territory.[1]

"Various opinions on the nature of the cell have passed current during the last thirty years, and almost each quinquenniad has had a theory of its own. Thus Schwann looked upon the *vitelline* membrane as the outer cell-wall, the yelk substance the contents, the *germinal vesicle* the nucleus, and the *macula* or *maculæ* the nucleolus or nucleoli. Wagner and Henle regarded the *germinal vesicle* as the true cell, and the other parts of the ovum as of the nature of superadded structures. Goodsir and Virchow held the cell to be the ultimate morphological element in which there is any manifestation of life, and that the seat of real action must not be transferred to any point beyond the cell. Still finer distinctions have been drawn of late years, and much said on 'plasms' and 'protoplasms' or 'plasmodiums' as rivals of the cell. The observations of the eminent phytologist Hugo Von Mohl on the 'Primordial Utricle,' Cienkowsky's views on the monads, espoused by Professor Huxley in his lectures on the *Invertebrata*, and Professor Haeckel's 'Protogenes,' may be cited in proof of the opinions afloat and pertaining to the ultimate atoms of organized bodies. The protogenes of the Jena professor is described as 'simply a minute drop of living jelly, simpler even than a white blood-corpuscle, having no nucleus, no nucleolus, no contracting vesicle—"no nothing" in fact, except the property of flowing in various directions, and of protruding innumerable fine processes or pseudopodia.' Here is a living substance devoid of all but molecular structure, yet showing by its pseudopodia the actions attributed to the lower forms of animal life—*ex. gr.* the *Amœba*. The question will now arise, If Haeckel's views be admitted, is plasm endowed with a formative and selective power in the building up and the disintegration and decay of organisms? Has science revealed a potential or pantheistic force—the universal Archeus—pervading every form of organized matter? Is it to be inferred that life is originally stamped on the amorphous and elementary molecule, that the molecule is advanced to a distinct and tangible organization in the cell as in the amorphozoa—the perfection of tissue being a further process of the cell in its entirety—anatomical and physiological? However this may be—and all that pertains to molecular morphology[2] is likely to undergo a thorough inquiry—Dr. Macvicar and others have space and verge enough in determining the intricate philosophy of matter. In all speculations resting on molecular and cellular growth it may be well to remember that the dogma of to-day may come to rank with the disbelief of to-morrow, or even be classified with an antediluvian past; and it is not less necessary to keep in view what history has oft recorded and repeated, but in vain, that the eccentricities of one age may become the wisdom of the next."

With the memoirs which are the production of John

[1] "This question was fully discussed in the 'British Medical Journal' (Jan. 12, 1861), in a leading article—'Cellular Pathology, its Present Position'—being a review of Virchow's work as translated by Chance The passages referred to in the text above are placed in parallel columns.

[2] "A Sketch of a Philosophy—Part II.—Matter and Molecular Morphology," published by Williams and Norgate, 1868, will furnish abundant materials to those interested in these inquiries. The chemical or elementary synthesis, rather than the anatomical and physiological relations of molecules, are discussed in this remarkable *brochure*.

Goodsir, a few are included which were written by his brother Harry. Those who knew the latter knew how great promise he made of becoming an able coadjutor of his elder brother, if not a successful competitor with him for the highest scientific honours. He perished with Franklin in the ill-fated Arctic expedition. Four papers in this collection attest his power of observation, his appreciation of the microscope as an instrument of research, and the bent of his genius towards the study of comparative anatomy. His early death was a great loss to science.

John Goodsir was born in 1814 at Anstruther, in Fifeshire, not far from Edinburgh. He was a son and grandson of distinguished medical men, and was early destined for the medical profession. He studied medicine at Edinburgh, and was an anatomical pupil of the late Dr. Knox. He early distinguished himself by his assiduity in the study of anatomy, and became as a student distinguished for the skill with which he made models of his dissections. In the early part of his career he became the friend of the late Edward Forbes, and for many years they lodged together in Edinburgh, each helping the other in the walk they had chosen. There is scarcely an Edinburgh graduate since 1838 up to the death of Forbes in 1854 that had not frequent opportunity of seeing them together. Large numbers remember the flat at 21, Mid-Lothian Street, so well described by Dr. Lonsdale:

"The domicle of the Goodsirs in No. 21, Lothian Street, adjacent to the University of Edinburgh, was approached by a public flight of stairs, to which six different families had access, and consisted of the half of a top flat or storey, with attics—rented at £17 a year! In character it ranked with the dwelling of petty tradesmen, and though the rooms were small they accommodated two or three brothers Goodsir, Edward Forbes, George E. Day—all very tall men, also their visitors, and a housekeeper or cook, and two lads who acted as anatomical assistants in the museum and as grooms-in-waiting at home. Man was not the sole occupant; other living things—biped, quadruped, manuped, and nulliped—had their share in the fortunes of the household. 'Jacko' the monkey,[1] 'Coco'

[1] "Jacko" was a droll customer, with a keen eye to his physical comforts. Looking upwards in the scale of being, or "aping his betters," he would have a vapour-bath, and in a mode that indicated neither propriety nor decorum. Watching his opportunity when the pot of boiling potatoes was removed from the fire, he used to warm his hips over the steaming vapours. Mr. Day, having caught him in the act, vowed he would eat no more potatoes unless presented in their dry jackets. After Goodsir observed the parasite on the gill of the haddock, Mr. Day came to have doubts as to the validity of fish in general; and as haddocks and potatoes were staple dishes in the establishment, his gastronomic squeamishness could only be allayed by Goodsir's assurance of the parasitic freedom of every fish, and

the tortoise, 'Cæsar' the dog, 'Doodle' the cat, and occasionally guinea-pigs and urchins, had their freedom of run in the establishment; the birds were caged, and the great eagle stood Prometheus-like on his Caucasus; whilst shut up in the attics, or claiming part of the cook's precincts, and in improvised *aquaria* or *vivaria*, were frogs, fishes, molluscs, echinoderms, and various odds and ends of *Invertebrata*. These animals were nearly all meant for physiological observation, and occasionally furnished the anatomists with a blood-globule, a muscular fibre, and ciliated epithelium. As the ranks of this living motley fell away—for amidst such a marine, aërial, and land population life flowed and ebbed, and oft departed—the organisms, on ceasing their physiological functions, obtained the obsequies of the scalpel, the injecting-syringe, the spirit-jar, or macerating-tub; and, as mementoes of once familiar faces, skins and crania for conservation might be seen hanging like banners on the outward wall or attic's roof. This semi-menagerie and its mortuary relics, conveying to more senses than one decided anatomical impressions, bore a faint resemblance to a portion of the monastery of the Capuchins in the Piazza Barberini at Rome, where, however, the *genus homo*, and not the *genera animalium*, constituted a more degrading demonstration. Along with household furniture, boxes, big tomes, portfolios, fossils, geological and archæological specimens, were strewed about the rooms; the finer sorts of things occupied shelves; and these again variously set off by dried starfishes, shells, trophies of the chase, meerschaums, and the artistic or grotesque fancies of Forbes. As indiscriminate as the Paris *chiffonniers*, the Goodsirs fraternity hoarded up organic forms and their special idols, till they realised what appeared to bystanders a chaos of natural history and domesticity only to be surpassed by the oddest curiosity-shop in the Cowgate of the ancient city. With the owners, however, there was method in the midst of strange confusion, besides much pleasantry in the conceit, and a kind of æsthetic halo that crowned all the dust and cobwebs of their domicile."

There is one thing the biographer has forgotten here; and that is a microscope. It was not one by Ross or Powell or Smith, but a second-hand one picked up by Forbes in a shop in Edinburgh. Be sure it was not a very good one, but, as Forbes used to say, "It is not the object-glass at one end, but the head at the other, that constitutes the value of the microscope." In this naturalists' den might be met from time to time George Wilson, John Reid, Samuel Brown, J. Hughes Bennett, James Simpson, Martin Barry, John Balfour, James Wilson, David Page,

the cook's declaration that "Jacko" was chained up during the preparation of the "gentlemen's dinner."

"Jacko," in a roving humour, descended by the spout on the outside wall to a lower storey, and finding the kitchen window open walked in, to the great dismay of the female inmate. Knowing nothing of the curious household above, and being much engrossed, as nearly all Scotch folk were at the time, with the threatened disruption in the Kirk, Mrs. ——— looked upon the intruder, whose presence was as mysterious as his person was horrid in her eyes, as "spiritually uncanny;" nay, as "the chains were broken," had not "the thousand years" ended, and here was "Beelzebub himsel'!"

John Percy, Lyon Playfair, Allan Thomson, and a number of others now living amongst us or passed away with honoured names.

Of discoveries made by the microscope at this period of Goodsir's life, we may mention that of the stomachic fungus, *Sarcina ventriculi*. This discovery is thus related by Dr. Lonsdale:

"His contributions to the different societies in Edinburgh (1841—1844) show how earnestly he laboured for a front place in the ranks, hoping by all laudable methods to put himself in a favorable position for any more lucrative or substantial appointment which might cast up. One of these contributions relating to the *Sarcina ventriculi* in cases of pyrosis or 'waterbrash'—a pretty discovery of itself for any man to make—helped to disclose much that had been obscure and enigmatical in digestion. The perversity of the stomachic functions, caused by the presence of organisms which no gastric juice could control, was viewed as strangely curious. The *Sarcina* attracted most attention in England, where stomach complaints disturb the gastronomical 'John Bull,' as the 'sair head' does the plodding Scot, and 'smotherings about the heart' affect the Irish Celt. The discovery attracted many by its novelty, though parasitical growth had for some time been a matter of discussion. In this country Professor Owen (1832) detected the presence of a greenish vegetable mould in the lungs of the *Phœnicopterus*, and was led to infer that internal parasites embrace entophyta as well as entozoa. Italian, French, and German observers, and notably Meynier, Schönlein, and Langenbeck, had written on parasitic growths; and Gruby of Vienna (Valentin's 'Repertorium,' 1841) had given a complete history of them, bestowing special attention on the crusts of the *Tinea favosa* made up of *Mycodermata*. Hughes Bennett in Edinburgh, Rayer and Cazenave in Paris, confirmed Gruby's views. Mr. George Busk gave an excellent review in the 'Microscopic Journal' (December, 1841) of all that had been done, and embodied his own researches with it, so that parasitic formation was one of the questions of the day when Goodsir discovered the stomachic enemy.[1] As *Sarcina* affects all phases of life, from Lazarus at the gate to Dives in the palace, Goodsir became involved in a large amount of correspondence with doctors and patients soliciting information and curative means. The history of the case gave him position and authority as a minute and accurate observer in little explored fields, and where natural history pursuits afforded light to strictly pathological questions."

In 1846 Goodsir was appointed Professor of Anatomy in the University of Edinburgh. From this time to the day of his death he devoted himself to the duty of teaching anatomy. He did not neglect the use of the microscope, and he had the satisfaction of seeing his colleagues, more especially Dr. Hughes Bennett, the Professor of the Institutes of Medicine, introduce this instrument into his practi-

[1] "If Edinburgh was first made acquainted with the *Sarcina*, so was its 'Philosophical Journal' the first to convey to the world, in 1819, Sir J. Herschel's researches on the hypo-sulphites—salts of such significance in counteracting the parasite.

cal teaching at the bedside in the Infirmary of Edinburgh. At the same time he directed all his leisure to the improvement of the museum under his charge. His lectures were eminently successful, and he devoted a certain portion of his time to giving demonstrations of anatomy in addition to his professional labours as a lecturer. In these demonstrations the microscope was constantly employed, and in the numerous papers which he subsequently published we find him making extensive use of this instrument. He based his physiological and morphological teachings on an accurate knowledge of the nature of the tissues which entered into the composition of the organs of the animals, and these alone could be understood by researches dependent on the aid of the microscope. Had he lived, Goodsir would have undoubtedly put his large knowledge of the laws which govern the functions and forms of animal life into a systematic treatise. As it is, we have from his pen a series of papers unrivalled in accurate observation and felicitous induction, and no one who wishes to master the results of biological science can dispense with the study of his writings. This work, embracing his most important papers, has been carefully edited by his successor in the Chair of Anatomy, Professor W. Turner, and contains a large series of plates illustrating the various structures to which reference is made in the text. To his large class of pupils, to students of minute structure, and the cultivators of physiological science, these volumes will be found a precious record of the observations and views of one of the profoundest physiologists this century has produced.

QUARTERLY CHRONICLE OF MICROSCOPICAL SCIENCE.

Histology. NERVE.—On the minute Anatomy of the Pacinian Corpuscles of Man and other Mammifers. By Dr. G. V. Ciaccio, Professor of Physiology at Parma. Turin, 1868. 4to, 5 plates.—Dr. Ciaccio was, five years ago, studying histology in this country with Dr. Lionel Beale. At that time he published a paper in this Journal; he has, since his return to Italy, written some valuable memoirs, one of which, on the Structure of the Skin of the Frog, he was good enough to send us. The illustrations, both in that and the present memoir, are very beautifully executed. This is a very detailed account of the Pacinian body, the methods of preparing the object for examination being first discussed in detail. Dr. Ciaccio concludes that the structure of these bodies is quite peculiar (he is not able to add much to what was previously known on this score, but gives valuable confirmatory evidence), and their function also must be regarded as a special one, which is at present unknown.

The Nerves of the Cornea. By H. Petermöller. 2 plates. *Zeit. f. Rat. Med.*, xxxiv, 1st part.

The Central Nervous System and the Auditory Organ of the Cephalopods. By Ph. Owsjannikow and Dr. A. Kowalewsky, *Mém. de l'Acad. Imper. des Sc. St. Petersbourg*, Tome xi, No. 3.—The authors give the microscopic structure of the ganglia and the microscopic relations of the nerve-fibres in several species of Cephalopoda. The structure of the auditory sac itself is elaborately worked out and figured. Several plates of double quarto size, and marvellously drawn, illustrate this paper. Owsjannikow's paper on the Lamprey's (*Petromyzon fluviatilis*) ear, in the same series of memoirs, furnishes an interesting comparison of the structure in the highly organised mollusc and the low-grade fish.

On the Auditory Organs of Molluscs. By M. Lacaze Duthiers. *Comptes Rendus*, November 2nd, 1868.—This paper is one of considerable importance, and one which should excite attention of all comparative anatomists. Since Siebold, Kölliker, and others drew attention to the otolithic sacs of Gasteropods, Leydig, Claparède, Huxley, and Lacaze

Duthiers himself, have stated that the sac derives its nerve in the large majority of cases (the Heteropoda and Eolidæ being exceptions), from the pedal ganglion, and the supposed innervation of the organ from the pedal ganglion led to various deductions as to the inconstancy of the innervation of homologous parts, and the connection between sensory and motor nerve-centres. M. Lacaze Duthiers has recently carefully looked into this question, and believes that he and other observers have been misled by the apposition of the otolithic sacs to the pedal ganglion, and that the auditory nerve comes to the sac really from the supra-œsophageal, also called cerebroid ganglion, and thus this ganglion is the nerve-centre of all the sensory organs. Dr. Lacaze Duthiers is an observer of the very greatest distinction and of known accuracy; we therefore must expect to see his observations confirmed, and would point to this inquiry as a worthy task for any of our readers. It is much to be regretted that these observations, so important in connection with the homologies of the Mollusca (for it was usual to determine the homologue of the pedal ganglion by the connection of the otolithic sac in doubtful cases), have been totally misrepresented in the pages of the 'Monthly Microscopical Journal,' and in the 'Popular Science Review.' The error has arisen from imperfect knowledge of the French language, and of the rudiments of molluscan anatomy.

Throughout the translation of Dr. Duthier's paper in the February number of the 'Monthly Journal,' the term "sus-œsophagien" is translated "sub-œsophageal," instead of "supra-œsophageal," and thus the very fact which Dr. Duthiers denies is most emphatically asserted in the translation of the paper; and the same mistake is made in the Chronicle of the 'Popular Science Review' for January. Is it possible that Dr. Lawson's contributor knows that in Molluscs the cerebral ganglion is supra-œsophageal, and the pedal ganglion is sub-œsophageal? The following passage and the subjoined translation in the 'Monthly' would lead one to suppose that it is impossible:—"Toujours le nerf acoustique prend son origine sur les ganglion sus-œsophogie ou cerebral." "The acoustic nerve invariably takes its origin from the subœsophageal or cerebral ganglion." 'Monthly Mic. Journal,' February, p. 115, six lines from top (and again two lines from the bottom).

We regret much that the space of a useful contemporary should have been wasted in propagating such error as the above. It is most necessary for us to correct it, as the observations of Professor Lacaze Duthiers on the subject are of so

much value; and, moreover, it is well to be on guard against similar errors in future in the new 'Journal of the Royal Microscopical Society.' The repetition of the error and complete perversion of the author's sense shows that the excuse of carelessness cannot be applied in this case. That the translator was puzzled by the contradictions which he himself elaborated is apparent from this sentence, which we give as printed:—"In the Heteropoda especially, the otolites are suspended from the brain (?) (cerveau), as if from a long delicate thread." The inserted note of interrogation and French word indicate an unenviable state of bewilderment.

Professor Lacaze Duthiers' researches have been made on more than thirty species of Gasteropods, and he has never failed to discover the relation of the auditory nerve to the cerebral ganglion. Limax, Arion, Helix, Zonites, Clausilia, Succinea, Physa, Lymneus, Ancylus, Neratina, Paludina, Testacella, Cyclostoma, Pileopsis, Calyptera, Natica, Nassa, Trochus, Murex, Cassidaria, Purpura, Patella, Haliotis, Bullœa, Aplysia, Lamellaria, are the genera in which this relation has been established. In these investigations oxalic acid was used as a re-agent to render the lime crystals in the auditory sacs apparent, and thus facilitate their dissection. Staining with carmine was also found useful. It will be observed that Professor Lacaze Duthiers' researches extend only to the Cephalophorous Mollusca. It will be of the greatest importance to ascertain how far his results are true for the Lamellibranchs. In Anodon the pedal ganglion is a very long way removed from the so-called supra-œsophageal ganglion, and on that pedal ganglion, supported by a peduncle, the otolithic sac is to be seen. The hope to establish minute homologies between Gasteropods and Lamellibranchs is, we are convinced, a vain one, but it is necessary to know how far they agree in structure.

Muscular Tissue.—On the Structure of Striped Muscular Tissue. Second article. By. W. Krause. *Zeitsch. für Rat. Med.*, xxxiv. 1st. Part.

Blood.—*Cohnheim's Views on the Passage of White Blood-Cells.*

Dr. Koloman Balogh opposes the view lately advanced by Cohnheim. He observes that the first writer on this subject was Aug. Waller, of London, who had already seen, in 1846, in examining the mesentery of the toad and the tongue of the frog, that the white and red globules of the blood can pass outside the walls of the capillary vessels. The different details of these observations had led Waller to conclude:

1st. That the white globules can open for themselves a passage through the uninjured walls of the vessels. 2nd. That the blood possesses a power of nutrition which permits it to rapidly close the orifice by which these globules passed out. In a second memoir Waller endeavoured to establish the identity of the corpuscles of mucus and of pus with the white globules of the blood. He did not regard the passage of the globules as necessarily a vital process, since he was able to observe it after death; and he considered that the phenomenon might be due to a solvent action exercised by the blood globules on the vascular walls. These researches of Waller appeared in the 'Philosophical Magazine' and fell into profound oblivion, even in England, until the moment when Cohnheim published his work on the same subject in 'Virchow's Archiv.' Dr. Balogh, wishing to check the experiments of Cohnheim, instituted, with the aid of Dr. Andreas Csabatamy, a great number of experiments on the mesentery of frogs, some poisoned by curare, others left intact. He noticed very readily the tendency of the white corpuscles to form agglomerations in the vessels at certain points; but, although he made repeated observations, sometimes for twenty-four hours, he quite failed to see even one white globule pass through the walls of the capillaries, or one that had so passed. Dr. Balogh, in the face of these negative results, asks what can have led Waller and Cohnheim to admit that the white globules of the blood can pass through vascular walls; also, if pus-cells cannot be formed in the connective tissue without the participation of the white globules of the blood; and, finally, if the white globules of the blood can be a source of the formation of pus. He considers the idea put forth by Waller and reproduced by Cohnheim as the result of optical errors. He does not deny absolutely the existence of some apertures in the walls of the vessels, but he is convinced that they would be too small to allow the passage of the globules. He could not see them with a new immersion objective of Hartnack, giving a magnifying power of 2,600 diameters; and he doubts if such apertures existed whether penetrating injections could succeed in the way they do. Besides, Keber, who described these pores, was unable to demonstrate them in a *réunion* of German naturalists and physicians, and the method of Recklinghausen (impregnation with silver) produces the appearance of orifices where nothing of the sort really exists. He considers the pus-cells seen outside the vessels to arise from the connective tissue; and the cells of the vessel walls may equally give rise to such. The white globules of the blood accidentally

escaping by rupture cannot, he believes, give rise to veritable pus at all.

Teeth.—How to Study the Structure of the Teeth. By Professor S. P. Cutler. *The Dental Register*, Nov., 1868. In giving my processes for the investigation of the teeth, I would like very much for all who have instruments to follow me and give their individual results. This course, I maintain, will at least reward any one, amateur or otherwise. In the first place, a good and reliable microscope will be prerequisite. Secondly, a thorough practicable knowledge of the use of the instrument will be indispensable.

To commence with the gum or soft pulp of a tooth.

Formula No. 1. Procure a fresh pulp, sound and normal, and put this into alcohol (ordinary), and let it remain several days, when it becomes firm and tough. Then remove from the alcohol, and with a sharp razor slice into thin longitudinal sections, as thin as possible, observing the order in which they are cut. They are now ready for mounting, and should be mounted in the order in which they are cut. Mount in balsam, label and number. This specimen will show sections of blood-vessels, cellular tissue, and portions of nerve-filaments, commencing with the first slice, and follow the order of their mountings.

Formula No. 2. Procure a fresh pulp as before, and treat same way in alcohol. Now remove, and commence at one end, and cut across at right angles to the pulp, and cut into thin slices, laying them aside in the order in which they were cut. Then mount, label, and number in the same order in which they were cut, as in the first process.

Formula No. 3. This time cut a pulp, prepared as above directed, obliquely from end to end, observing the same angle through the entire pulp; lay aside and mount as in the other cases.

In the above specimens the filamental septum may be imperfectly seen and studied, though not satisfactorily, as the cell contents will obscure the nerve fibrils, though not entirely so. For the above processes pulps of single teeth are preferable to begin with; then the molars may be studied in the same way. When the pulp is removed from the alcohol it is white and tough, and should be cut and mounted as soon as possible, before it hardens too much.

Formula No. 4. Procure a fresh pulp, and at once split it open from end to end; then lay it on a slip of glass slightly coated with balsam pitch, and spread it out, after slightly rounding the glass (something like a hunter stretches his coon skin on a barrel to dry); then remove as much of the

cell contents as convenient, by washing with a piece of sponge and acetic acid or ether, rubbing lengthwise with pulp. This will show more clearly the septum of filaments, and also show the countless openings through the pulp membrane, where the fibrils pass out into the dentine. These specimens will not keep well for permanent use, unless mounted in pitch on both sides; even then changes take place.

Formula No. 5. Fresh pulps may be dissected into small patches, or torn to pieces and mounted as above directed, which will show more or less of the structure of the interior of the pulp; patches of nerve fibres or filaments may be seen intact.

Formula No. 6. Remove fresh pulps and let them dry a day or so; then with a short pointed bistoury or scissors split open the pulp from end to end, and spread out on coated glass as before directed, mount and label. In these specimens the openings through the membrane may be distinctly seen, also the system of nerves as heretofore described in former articles, though not entirely intact, but more or less distributed. The above are the leading features of preparing pulps for the microscope, though many other methods may be employed, none of which will be entirely satisfactory to the beginner.

In the case of dried pulps, they may be put into water and swelled, then split open, dissected, and examined.

A new set of formulas will now be given, which will show the filamental system to perfection and *in sitû*, and, cell structures and blood vessels generally being obliterated by differentiation, only in some instances the vessels may be seen with their contents. As we lack terms to fully describe this process, I will suggest something new, as ossification and calcification neither are expressive. Dentification, which is in use, and the most satisfactory, does not fully give the process; instead, I would suggest the terms *dentificatio pulpæ* or *dentum secundum*, meaning secondary dentine. Another form of hardened pulp, depending on another cause, might be termed with propriety *nodosa pulpa*, or granulated pulp, and may consist of one or more granules, round or irregular in shape.

The former depending on wearing down of the tooth by mastication, and the latter depending on irritation from decay and other causes, is always confined to the limits of the pulp, and never adherent to the inner walls of the dentine. The former process may be considered as physiological, and the latter as pathological. One anticipated by nature, or the *vis*

medicatrix naturæ, and ample provision made when the process is normal. In the latter case no such result is anticipated, and no constant saving provision instituted; on the contrary is infrequent and accidental, happening, probably, in certain temperaments only.

In both cases the result is the same, so far as these processes are viewed under the microscope—that is, the filamental arrangements of the nerves are in both cases intact, and show beautifully the plexuses of nerves occupying the interior of the pulp already described.

The processes may be compared to petrifying processes in inorganic chemistry, soluble lime salts filling up the cells and around the nerve fibrils, leaving these structures perfect and intact. Cell walls also remain, only their contents being replaced by lime, the blood vessels generally being filled with lime, or are absorbed and disappear.

The precise nature of these changes is not well understood, though the result may be readily comprehended. Without the aid of these secondary formations the true system of pulp structures never could be satisfactorily studied.

Specimens may be sawed with main-spring saws through crowns and roots when the pulp is ossified, including the pulp, showing the filamental system through the primary and secondary dentine in a perfect state of preservation. Section after section may be cut through the tooth and pulp in thin slices, and dressed down on a fine hone, first sawing through the centre; then saw off thin slabs on each side, dress down and saw as before; dress down again and saw until all the pulp is sawn up. These sections may be cemented to slips of glass with Canada balsam: pitch the dressed side to the glass, then dress down on a hone until light readily passes through it, then introduce under the instrument, and if not thin enough to show the nerves distinctly, dress down until they can be seen; if too thick, same as in preparing ordinary tooth specimens. This secondary nodes, or nodular dentine, is not true secondary dentine, though very similar, and might be included, perhaps, under the head of calcification, which may take place in any tissue, especially in advanced life, depending on similar causes, that is stasis in the part, and deposit of lime, and is an accidental circumstance, and may serve as a protection to the pulp against further ravages of decay. In both forms of secondary dentine the remaining soft portions of the pulp retain their vitality to a certain extent, varying in different cases.

It will be found that in case of wearing of teeth of old persons there is evidence of tubular disturbance, especially

near the former boundaries of pulp cavity, sometimes throughout the dentine. The connection and continuation of tubuli will be distinctly seen, and traced from primary to secondary dentine, the regularity of the primary disappearing in the secondary dentine. Slips of glass, Canada balsam, spring wooden clamps, or clothes-pins, a spirit lamp, saw, and hone, are all that is necessary to prepare specimens. The pitch is formed by gently evaporating the balsam over a spirit lamp until when cold it becomes hard, and of a brown colour.

The Homologies of the Dental Plates and Teeth of the Proboscidiferous Molluscs. By G. Denis Macdonald, M.D., F.R.S. *Annals and Mag. Nat. Hist.*, Feb., 1869.

Connective Tissue.—Development of Connective Tissue in the Placenta. By Prof. Rudolph Maier. *Virchow's Archiv*, 1st part, 1869.

On the so-called "Bindesubstanz" of the Central Organs of the Nervous System. By J. Henle and F. Merkel. 3 plates. *Zeitschrift fur Rat. Med.*, vol. xxxiv, 1st part.

Gland.—On the Development and the Structure of the Spermatic Particles of Fishes. By Ph. Owsjanikow. *Melanges Biologiques de l'Acad. Imp. St. Petersbourg*, September, 1868. —The author has sent to us a German abstract of his paper, and the original in Russian, with a plate. He discusses the views of Kölliker, Schweiger-Seidel, and La Valette St. George.

General.—Studies on the Nervous, Muscular, and Glandular System of the Crayfish (*Astacus fluviatilis*). By Dr. Victor Lemoine. *Annales des Sciences Naturelles*, 1868.—This is an exceedingly careful study of a very common animal, and is therefore likely to interest many of our readers. There is always something of value to be ascertained by detailed study of even these commonest forms. The glandular system has received especial attention from M. Lemoine; and the structure of those bodies thought to be the homologue of the cement-glands of Cirrhipedes is minutely described.

The Luminous Organs of *Lampyris noctiluca*. By Ph. Owsjannikow. *Mém. de l'Acad. Imper. St. Petersbourg*, tome xi, No. 17.—This is a memoir in German. The researches of Max Schultze are referred to, but not those of Prof. Targione Tozzetti, whose paper we mentioned last year.

The Animal "Cell" not essentially different in Function from the Vegetable.—In a paper read before the Association of German Naturalists, at its last session in Frankfort, on the "Physics of the Cell," Herr Wundt stated as follows:—It used to be thought that the vegetable cell had to form organic

matter, and that the animal cell had to destroy it in order that, by its alternation of creation and destruction, the general end of life might be attained. At present we are compelled to admit that, if the vegetable cell is the seat of a phenomenon of reduction by which carbonic acid is decomposed into its elements, a similar phenomenon is produced in the animal cell. Non-azotised combinations, it is now known, can be formed in the interior of the animal cell. Alexander Schmidt was the first to observe that, after the addition of carbonic acid to blood, the total contents of carbonic acid diminished in certain circumstances. This observation furnishes direct support to the idea of a phenomenon of reduction. The blood globule plays, therefore, a part analogous to that played by chlorophyll in the vegetable cell in contact with the carbonic acid of the atmosphere. The only difference which exists is, that in the blood-cell there is, besides, a process of oxidation going on which surpasses the process of reduction. Just as the chlorophyll of the vegetable cell absorbs carbonic acid, so does its colourless protoplasm absorb oxygen, and this corresponds completely to the absorption of oxygen by the blood-cell in the lungs.

Structure of Akazga Stems. By Dr. Fraser. *Proc. Botan. Society of Edinburgh.*—The author endeavoured to ascertain the differences between akazga and nux vomica by examining the microscopic anatomy of their stems. The following descriptions indicate the principal characters of these :—

Akazga.—The *pith* consists of complete parenchyma. Its cells have, in transverse section, a more or less regularly hexagonal form, and, in longitudinal section, they present the appearance of four-sided parallelograms. Their transverse diameter varies from $\frac{1}{300}$th to $\frac{1}{1500}$th of an inch, being usually, however, about $\frac{1}{800}$th; while their longitudinal diameter is from $\frac{1}{40}$th to $\frac{1}{600}$th of an inch. The majority of the cells are indurated and marked by radiating canals. A few non-indurated cells occur irregularly throughout the pith, and these contain starch granules.

The *wood-cells* have pretty constantly a diameter of $\frac{1}{2000}$th of an inch, and are greatly indurated, the cavity being so much reduced in size as to appear, in cross-section, like a point. Such a section also shows that the wood-cells are divided into irregular four-sided groups; firstly, by numerous medullary rays, which vary greatly in thickness—some consisting of only one layer of cells, and others of three or four; and, secondly, by portions of concentric rings, which consist of plates of parenchyma placed at right angles to the

medullary rays. The *dotted ducts* are almost invariably placed within these parenchymatous plates. They are nearly circular in form, though sometimes compressed radially, and, at others, concentrically; and they vary in diameter from $\frac{1}{400}$th to $\frac{1}{1000}$th of an inch, usually, however, being $\frac{1}{500}$th. Longitudinal cylindrical tracts of delicate parenchyma surround the pith, and occur also in various portions of the wood. In the latter situations, these tracts vary from $\frac{1}{100}$th to $\frac{1}{150}$th, and, in the former, from $\frac{1}{50}$th to $\frac{1}{80}$th of an inch in diameter.[1]

The cells of the medullary rays and of the concentric plates of parenchyma are filled with starch granules of moderate size (about $\frac{1}{4000}$th of an inch in greatest diameter) and of irregular oval forms, which seem identical in appearance with the starch granules in the non-indurated pith cells.

The corky layer and cellular envelope of the *bark* are moderately developed. In the endophlœum the development of bast cells is very slight, only a few isolated bast cells being seen in cross-section. Immediately internal to these, however, there is a distinct layer, about $\frac{1}{400}$th of an inch thick, and three or four cells deep, of indurated parenchyma, the cells of which are small and of various shapes, and exhibit radiating canals.

Strychnos Nux vomica.—The *pith* is only slightly indurated; and, in the sections examined, its cells almost invariably contain starch granules—a very few nearly perfectly indurated cells are, however, present. These cells vary considerably in diameter, some being met with of $\frac{1}{2000}$th of an inch, and others of $\frac{1}{600}$th. The majority of the smaller cells occur at the circumference of the pith.

The *wood-cells* are of the same character as those of akazga. The cylindrical tracts of delicate parenchyma are, however, larger, and much more numerous than those in akazga.

The *dotted ducts* are also more numerous, and, in place of being arranged singly or in groups of two or three, they frequently occur in groups formed of radial lines of five or six. In consequence, apparently, of this great development in the number of the dotted ducts, the wood of nux vomica, is divided into much smaller masses than that of akazga.[2]

The general botanical characters of the akazga plant, the minute anatomy of its stem, the nature of its poisonous action,

[1] Similar tracts of parenchyma have been observed by Professor Oliver in *Strychnos toxifera* (Oliver "On the Stem of Dicotyledons," 'Nat. Hist. Review,' vol. ii, 1862, p. 317).

[2] This structural character of nux vomica is apparent on simple inspection of a cross section.

and the chemical and physiological properties of the alkaloid that it contains are, therefore, sufficient to show that it is nearly allied to *Strychnos Nux vomica*; but they are also sufficient to distinguish it from that plant. It will be interesting to see how far this opinion is confirmed when an opportunity is obtained for examining its floral structure, and thus ascertaining its affinity with certainty.

In the parcels of akazga received there were a few leafless stems, which were found to contain an immense number of sparkling crystals beneath the bark. These stems also differ from the others in the exterior of the bark having a smooth appearance. A microscopic examination of the stem revealed the following characters:

The *wood* has the same general structure as that already described as belonging to akazga, the wood-cells being greatly indurated, and the medullary rays being arranged in the same manner. The cross-plates of parenchyma in connection with the dotted ducts are, however, shorter in cross-section, hardly extending beyond the immediate neighbourhood of the dotted ducts.

The *pith* contains very few indurated cells.

In the inner portion of the *bark*, and also in the longitudinal cylindrical tracts of delicate parenchyma traversing the wood, a number of prismatic crystals, terminated in domes, occur. These are arranged longitudinally to the stem.

There is no layer of indurated parenchyma in the bark.

Guided by these characters, Professor Dickson—who had kindly interested himself in the subject—pronounced that these were not stems of akazga. Dr. Fraser was at first unwilling to adopt this opinion, but a physiological and chemical examination has now convinced him of its correctness; for the bark of these stems is perfectly inert, and the alcoholic extract that is obtained from it does not possess the well-marked chemical reactions of that obtained from akazga.

On the Staining of Microscopical Preparations. By Dr. W. R. M'Nab. The author enumerated a large series of experiments he had made by staining certain microscopical structures with acetate of mauvine and Beale's carmine solution. He showed that by means of staining, the high powers of the microscope can be used to bring out points of structure not easily demonstrated without being so treated. The process of staining does not seem to be attended with any great difficulty, and the author believes that very important results may be obtained by careful study of its action on germinating plants.

Mineral.—The Different Colours of Labradorite. A microscopical examination of a number of specimens of this mineral in the collection of the Ecole Polytechnique des Pays-Bas, all from the Labrador coast, has enabled M. Vogelsang to give an explanation of the splendid play of colours often exhibited by it. In the coloration of labradorite its more or less crystalline structure plays an essential part, for the coloured specimens show usually a better cleavage than the colourless ones. The bright blue reflected by some specimens depends upon a certain crystalline state of the mineral, and is a phenomenon of polarisation produced by the passage of rays refracted by one lamina into another lamina, the planes of vibration of which do not coincide with those of the first, the result being a difference of phase and an interference of the luminous rays on reflection, just as with the ordinary colours of polarisation. The golden-yellow colours proceed from a total reflection from interposed microlites, which consist of magnetic oxide of iron, or else of diallage; the red colour results from the reddish colouring of small lamellæ of diallage; the association of these colours with the bluish reflection accounts for the green and violet play of colours; lastly, the coloured metallic reflection from laminæ of diallage gives rise to the effects of coloured aventurine. — *Archives néerlandaises des Sciences exactes et naturelles.*

The Application of the Microscope to Mineralogy.—Mr. H. C. Sorby exhibited specimens illustrating this subject at the soirée of the Royal Society.

The following substances can be recognised in transparent minerals or blow-pipe beads by means of the characteristic absorption bands seen in the spectra, even when they are much coloured by the oxides of iron, manganese, or nickel, viz., Didymium, Erbium,[1] Uranium, Cobal, Chromium, Copper, Manganese (when it occurs as permanganic acid), a new earth, for which the name *Jargonia* is proposed, and another substance, perhaps also new, but not yet sufficiently studied.

Jargonia is an earth closely allied to zirconia, existing in small quantity in zircons from various localities, but constituting the chief ingredient of some of the jargons from Ceylon. It is, however, distinguished from zirconia and all other known elementary substances by the following very remarkable properties. The natural silicate is almost, if not quite colourless, and yet it gives a spectrum which shows above a dozen narrow black lines, much more distinct than even those characteristic of salts of didymium. When melted

[1] Erbium of Bunsen—Delafontaine's Terbium.

with borax it gives a glassy bead, clear and colourless, both hot and cold, and no trace of absorption bands can be seen in the spectrum; but, if the borax bead be saturated at a high temperature, and flamed, so that it may be filled with crystals of borate of jargonia, the spectrum shows four distinct absorption bands, unlike those due to any other known substance.

New Applications of the Microscope to Blow-pipe Chemistry.—Of these there are two chief divisions. In one method the substance is fused with borax or microcosmic salt, so as to give a clear bead, and the spectrum is examined by means of the spectrum eye-piece. In the other method the saturated borax bead is kept hot over the lamp, so that crystals may be deposited in it. By using a microscope many elements may then be easily distinguished by the form of the crystals, which are often of extreme beauty. When, however, much mixed, or combined with silica or other acids, as in natural minerals, it is often requisite to add various re-agents, as phosphate of soda, microcosmic salt, boric, tungstic, molybdic, and titanic acids. These give rise to characteristic crystalline deposits; and we may thus distinguish lime, magnesia, baryta, and strontia, even when combined with silica; and can detect magnesia when mixed with several times its weight of lime in impure limestone, &c.

Examples of this method.—1. *Sphene* melted with borax does not deposit crystals; but the addition of boric acid sets free the titanic acid, easily recognised by the form of the crystals. Diluting the bead with more borax, so as to retain the titanic acid in solution, phosphate of soda causes the deposit of crystals of phosphate of lime.

2. *Fergusonite*, from Greenland, shows the spectrum of didymium, and from Ytterby that of erbium. When fused with borax it deposits crystals of columbic acid; and after diluting with borax to prevent this, the addition of phosphate of soda produces crystals of phosphate of yttria.

3. *Gadolinite* from Ytterby melted with borax gives a spectrum indicating the presence of didymium and erbium; and when kept hot it deposits the characteristic crystals of borate of yttria.

Embryology.—Germination of the Spores of Varicellaria. By Dr. W. Nylander. *Annals of Natural History* (December), translated by the Rev. W. A. Leighton.—The spores of Varicellaria, which are the largest spores of all lichens, were placed by Nylander in a humid atmosphere, and—as seen by De Bary and others—were soon covered with slender circumradiant filaments. In the course of a month or so these

filaments acquired a mucedinous character, and produced moniliform hyaline penicillate acrospores, and thus constituted a slender *penicillium*. This subsequently disappears under culture. But before it disappears, he has observed in the endospore a hyaline protoplasm, turbid in the middle, composed of very minute white granulations, which, as it were, by coagulation formed a solid white corpuscle in the cavity of each cell of the spore, and that this afterwards gradually increased after the fashion of an embryo, and at length, in the third month, filled the entire cavities of both cells of the endospore. At the same time, the wall of the two cells showed the concentric strata to have become sensibly looser, and was fissured by several fine transverse rimulæ preparing for its future dissolution, which a parasitic mucedinous vegetation would also promote. Dr. Nylander has noticed these phenomena from March till June. Then the spores, denuded of *penicillium*, show a white corpuscle in each cell, which distends the spiral wall, and ultimately expels an oblong corpuscle, which, when free, enlarges, and is most probably the commencement of the thallus of the lichen.

On the Change of the Gonidia of Lichens into Zoospores. By MM. A. Famnitzin and J. Boranetsky. *Ann. des Sci. Nat.*, Ser. 5, vol. viii, translated in the *Annals and Mag. Nat. Hist.*, February, 1869.—The authors of this valuable account of the reproduction in lichens observe—

"The most delicate and at the same time most important point of these researches was to establish incontestably that the zoosporal cellules were really the gonimic cellules, and not some other organism which had been accidentally developed in our apparatus. We believe that the following facts demonstrate this fully:

"1. We obtained the zoospores by means of gonidia sown on the surface of bits of bark previously boiled in water, and consequently cleansed from living organisms. Direct observation has demonstrated, moreover, that our seed-beds did not contain any other green organism besides the gonidia which we had deposited in them, and that they were only polluted by some filaments of a Hyphomycetes which had probably been transported on the bark or existed in the water in which the lichen had been macerated.

"2. The changes which we have described were observed not only in a very great number of free gonimic cellules, but also in gonidia still attached to the medullary filaments. From these latter we have repeatedly observed the zoospores to escape; and under the action of iodine the membrane of

these cells was coloured violet, whilst the extremity of the filament to which they were attached was of a pale yellow.

"3. We have equally obtained zoospores from gonidia united into a considerable mass. Some, indeed, of these cellules were already empty, the zoospores having escaped, whilst, on the other hand, others had undergone no change.

"4. Lastly, we have found, on the bark of a birch tree in the garden of the University (of St. Petersburg), green patches exclusively formed of free gonidia, completely destitute of thallus. These cellules also produced zoospores perfectly identical with those of the gonidia which we had sown.

"The formation of zoospores by sowings requires always many weeks, as the following experiments demonstrate:

"*First experiment.*—Vertical sections of a thallus of Physcia were placed, March 13, on fir-bark. The issue of zoospores was first observed April 19.

"*Second experiment.*—On March 21 a bit of lime-bark with a lichen growing on it was fixed on the exterior of a large glass vessel filled with water, which was made to fall on it drop by drop by means of a cotton wick curved siphon-like. On April 1 the filaments of the lichens were disintegrated. On April 3 we transferred the gonidia, as well as the mucous mass of decomposed filaments, to two bits of bark. On April 20 the zoospores appeared.

"*Third experiment.*—The lichen was immersed until the complete disintegration of the filaments, and on April 3 the gonidia were placed on gravel, on the earth, and on bits of rotten wood. Those on the two former became decomposed by too much moisture; but those on the latter succeeded well, and on May 15 the zoospores were observed.

"The gonidia which did not produce zoospores separated into a great number of motionless spherical cellules, amongst which we distinguished two forms—one presenting a protuberance at the commencement of the division, the others preserving to the end their regular spherical form.

"We also submitted these two lichens to similar experiments, except that, instead of vertical sections of the thallus or of gonidia already isolated, we used the soredia from the surface of the thallus, and sowed them either on bark or bits of decayed wood. Their gonidia presented precisely similar results to those of the Physcia, both in their form and their ulterior development.

"These observations authorize us to propound the following propositions:

"1. Not only Algæ and Fungi, but Lichens also, are provided with zoospores.

"2. Zoospores have been discovered in three very different genera of Lichens, viz. Physcia, Cladonia, and Evernia; and as these genera were selected undesignedly, it is probable that zoospores exist in all other lichens furnished with chlorophyll.

"3. We have demonstrated the identity of free gonidia with the unicellular Alga Cystococcus of Nägeli; consequently this is not a distinct genus, but only a phase of development of a lichen.

"4. The culture of the freed gonidia of Physcia, Cladonia, and Evernia led us to expect that other lichens would afford forms corresponding with rudimentary Algæ. Our researches prove this to be well founded. Vertical sections of the thalli of Peltigera and of Collema, cultivated on moist earth, showed the filaments in disintegration, the augmentation in size of the gonidia, and their transformation into glomerules composed of spherical cellules. The gonimic cellules of Peltigera and Collema continued to live when separated from the thallus: those of Peltigera were identical with an Alga called Polycoccus; those of Collema produced organisms similar to Nostoc. Consequently these three genera of Algæ, hitherto regarded as different and distinct, are in reality only the gonidia of lichens in a state of development when separated from the thalli which produced them."

Microzoology. L'Origine de la Vie (preface par F. A. Pouchet.) By Georges Pennetier.

This work, published by Rothschild, of Paris, gives a fair exposition of the views of the experimental heterogenists, amongst whom M. Pouchet is most prominent. All the old experiments, the precautions taken to prevent error, the conditions necessary for success, and the various 'forms' 'spontaneously' generated, are here given in a well-written, popular neat little book. The figures, which are in the objectionable style of white on a black ground, are certainly inadequate, and can give but the vaguest notions. No new argument is added to the case stated by the heterogenists; in fact, none can be. They say 'our experiments are perfect; we exclude all possible error by admixture of atmospheric or other diffused germs, and yet in certain solutions we obtain life.' There is no possibility of discussion with these philosophers; all we should ever think of doing in the matter is to deny the accuracy of the experiment. Experiments prove next to nothing in this matter; for an honest man must admit the vast possibility of error. The question of heterogeny is

one for the philosophic biologist, rather than the experimentalist with his flasks, and decoctions, and air from the Pyrenees, and we do not know of one such who has been led to believe that Bacteria and Vibriones are produced casually from unorganized matter, though many believe in the possibility of the evolution of organic from inorganic matter.

Appendix to the Principles of Biology. By Herbert Spencer. This is a reply to a criticism of Mr. Spencer's philosophy which appeared in the *North American Review*. The reviewer charged Mr. Spencer with tacitly repudiating the belief in spontaneous generation, although endeavouring to prove the origin of *all organic life by gradual development*. To this Mr. Spencer replies that he does not believe in the "spontaneous generation" commonly alleged, and referred to by the American reviewer. And he continues:—"So little have I associated in thought this alleged 'spontaneous generation' which I disbelieve, with the generation by evolution which I do believe, that the repudiation of the one never occurred to me as liable to be taken for repudiation of the other. That creatures having *quite specific structures* are evolved in the course of a few hours, without antecedents calculated to determine their specific forms, is to me incredible. Not only the established truths of Biology, but the established truths of science in general, negative the supposition that organisms having structures definite enough to identify them as belonging to known genera and species, can be produced in the absence of germs derived from antecedent organisms of the same genera and species. If there can suddenly be imposed on simple protoplasm the organization which constitutes it a *Paramœcium*, I see no reason why animals of greater complexity, or indeed of any complexity, may not be constituted after the same manner.

"If, accepting these alleged cases of 'spontaneous generation,' I had assumed, as your reviewer seems to do, that the evolution of organic life commenced in an analogous way; then, indeed, I should have left myself open to a fatal criticism. This supposed 'spontaneous generation' habitually occurs in menstrua that contain either organic matter, or matter originally derived from organisms; and such organic matter, proceeding in all known cases from organisms of a higher kind, implies the pre-existence of such higher organisms. By what kind of logic, then, is it inferrible that organic life was initiated after a manner like that which *Infusoria* are said to be now spontaneously generated? Where, before life commenced, were the superior organisms from

which these lowest organisms obtained their organic matter? Without doubting that there are those who, as the reviewer says, 'can penetrate deeper than Mr. Spencer has done into the idea of universal evolution,' and who, as he contends, prove this by accepting the doctrine of 'spontaneous generation:' I nevertheless think that I can penetrate deep enough to see that a tenable hypothesis respecting the origin of organic life must be reached by some other clue than that furnished by experiments on decoction of hay and extract of beef.

"From what I do not believe, let me now pass to what I do believe. Granting that the formation of organic matter, and the evolution of life in its lowest forms, may go on under existing cosmical conditions; but believing it more likely that the formation of such matter and such forms took place at a time when the heat of the earth's surface was falling through those ranges of temperature at which the higher organic compounds are unstable; I conceive that the moulding of such organic matter into the simplest types, must have commenced with portions of protoplasm more minute, more indefinite, and more inconstant in their characters, than the lowest Rhizopods—less distinguishable from a mere fragment of albumen than even the *Protogenes* of Professor Haeckel. The evolution of specific shapes must, like all other organic evolution, have resulted from the actions and reactions between such incipient types and their environments, and the continued survival of those which happened to have specialities best fitted to the specialities of their environments. To reach by this process the comparatively well-specialised forms of ordinary *Infusoria*, must, I conceive, have taken an enormous period of time.

To prevent, as far as may be, future misapprehension, let me elaborate this conception so as to meet the particular objections raised. The reviewer takes for granted that a 'first organism' must be assumed by me, as it is by himself. But the conception of a 'first organism,' in anything like the current sense of the words, is wholly at variance with conception of evolution; and scarcely less at variance with the facts revealed by the microscope. The lowest living things are not, properly speaking, organisms at all; for they have no distinctions of parts—no traces of organization. It is almost a misuse of language to call them 'forms' of life: not only are their outlines, when distinguishable, too unspecific for description, but they change from moment to moment and are never twice alike, either in two individuals or in the same individual. Even the word 'type' is applicable

in but a loose way; for there is little constancy in their generic characters: according as the surrounding conditions determine, they undergo transformations now of one kind and now of another. And the vagueness, the inconstancy, the want of appreciable structure, displayed by the simplest of living things as we now see them, are characters (or absences of characters) which, on the hypothesis of Evolution, must have been still more decided when, as at first, no 'forms,' no 'types,' no 'specific shapes,' had been moulded, That 'absolute commencement of organic life on the globe,' which the reviewer says I 'cannot evade the admission of,' I distinctly deny. The affirmation of universal evolution is in itself the negation of an 'absolute commencement' of anything. Construed in terms of evolution, every kind of being is conceived as a product of modifications wrought by insensible gradations on a pre-existing kind of being; and this holds as fully of the supposed 'commencement of organic life' as of all subsequent developments of organic life. It is no more needful to suppose an 'absolute commencement of organic life' or a 'first organism,' than it is needful to suppose an absolute commencement of social life and a first social organism."

The Spontaneous Formation of Leucocytes. By M. Onimus. *Robin's Journ. de l'Anatomie*, November and December, 1868. This is the most convenient place to draw attention to these researches, connected as they are in interest with the subject of spontaneous generation.

M. Onimus believes he has proved that a perfectly amorphous liquid, like that formed under the ampulla of the epidermis, raised by a blister, is capable of developing corpuscles identical with those of the chyle and blood. In his first experiments the liquid from a blister, previously filtered, was injected under the skin of a warm-blooded animal. In a short time the liquid was found full of leucocytes. In the present paper M. Onimus gives full details of more elaborate experiments, and combats the arguments urged against him. He states that many of the inquiries have been conducted under the eyes of MM. Legros and Robin, who have verified them; and he quotes some observations of M. Bernard which endorse his views. In his latest experiments he separated the liquid to be experimented on from the blood by means of parchment or membrane, and he thinks that the white globules could not have made their way through this. There is, however, reason to believe from other observations that this passage is at least within the range of possibility.

On the Molecular Origin of Infusoria. By Dr. Hughes

Bennett. *Popular Science Review*, January, 1869. This is a statement of the views of experimental heterogenists.

On the Thalassicollidæ. By G. C. Wallich, M.D. *Ann. and Mag. Nat. Hist.*, February, 1869. 6 pages. — Dr. Wallich gives a sketch of Huxley's observations published in 1851, and mentions some facts with regard to small specimens of Sphærozoum and Acanthrometra, which lead him to consider the former identical with Collosphæra. Dr. Wallich is not more inclined than any one else to regard the Thalassicollidæ as intermediate forms between Sponges and Foraminifers. He compares the branching fibrils to those within the cyst of Noctiluca, but then observes that those of Noctiluca probably differ very much in their nature. There is no example of phosphorescence, says Dr. Wallich, amongst living animals so low in the scale as Rhizopods. Crustaceans, Entomostraca, Ascidians, furnish a luminous secretion, which Dr. Wallich could detach with a brush; and the writer has observed a similar secretion in the Annelid Chælopterus. No Rhizopod is sufficiently organised to elaborate such a secretion is Dr. Wallich's conclusion.

Deep-Sea Protozoa. By Dr. G. C. Wallich.—In the new journal of the Microscopical Society, Dr. Wallich makes some remarks on Professor Huxley's paper on Coccoliths and Bathybius ('Quart. Journal Microscopical Science,' October, 1868). He says—"I may state that, after a careful and long-continued study of these organisms, whether occurring as free floating inhabitants of the surface waters of the Indian Ocean and tropical portion of the Atlantic, as constituent particles in the deposits being formed at the bottom of existing seas, or amongst the fossil earths of the Post-tertiary period, I see no reason to alter my opinion by regarding the free Coccoliths as having been derived from any other source than their parent Coccospheres. In some deep-sea deposits, as stated by Prof. Huxley, free Coccoliths do certainly occur in overwhelming number as compared with Coccospheres. But, on the other hand, it is equally true that, at times, Coccospheres are present in great abundance, whereas free Coccoliths are, comparatively speaking, scarce. Coupling these facts, therefore, with another very important one, namely, that perfect Coccospheres are to be met with of every intermediate size between the $\frac{1}{3000}$th and $\frac{1}{830}$th of an inch in diameter or length, I am induced to believe that the free Coccoliths are formed in every instance on, or *pari passu* with, the spheroidal cells on which they rest; the state of attachment to these cells being the normal as well as pristine condition. That they revert at any future stage of their life

history, after once becoming free, to their original composite state, there is no recorded evidence forthcoming to prove.

"The question here arises, have these bodies any intimate connection with the origin or development of the Foraminifera of the deep-sea deposits? Now, although the evidence on this head is very far from being conclusive, it is, I venture to say, sufficiently definite to countenance such a view. In some of the deposits in which both Foraminifera and Coccospheres abound, Coccoliths are to be met with arranged in an order so like that in which they occur on the Coccosphere cells, both on individuals of the *Nodosarian textularian*, Rotalian, and Globigerine types, that no reasonable doubt can exist of their having more than a mere accidental relation to the surfaces they rest upon. Thus I have found, side by side, the perfect Coccosphere with its full complement of Coccoliths still adherent, and cells on which the number of persistent Coccoliths gradually dwindled down till only one or two remained, and it became impossible to determine whether I was looking at a Coccosphere cell or a 'primordial segment' of a Foraminifer. In both cases (as formerly pointed out by me in 'The Annals') the characteristic cross evoked by the polariscope is observable, whilst the density and specific texture of the cell or shell varies apparently with its age; until, in some specimens, we have actually presented to us the complete Foraminifer studded externally, throughout its surface, with the Coccoliths in regular series. The subjoined extract is taken from a volume of MS. figures and descriptions which I had the honour of presenting to the Royal Microscopical Society of London last year, and relates to a mature eight-chambered Textularian shell, each segment of which is studded with Coccoliths. The specimen referred to was obtained along with numerous others, from a depth of 1913 fathoms (upwards of two miles) between the coasts of Greenland and Labrador.

"'The eight cells constituting the Textularia are quite perfect, and increase in size in the usual manner, from the earliest-formed to the last-formed chamber. The Coccoliths on each chamber are placed in so regular an order as to leave no doubt whatever regarding their being component portions of each calcareous cell. Their structure, moreover, from the clear character of the entire shell, is distinctly visible even under a $\frac{1}{4}$-inch lens. Textulariæ thus constituted are by no means so rare as I imagined when I wrote the notice of the discovery in 'The Annals' (already referred to above). In every slide of certain soundings one or more generally occur. The material of this slide has been boiled in *Liq. Potassæ*

without any apparent effect on the Coccoliths or Coccospheres. Close by, but detached from the Textularia here figured, are several perfect Coccospheres, by means of which a ready comparison and proof of the identity of the cells of the Foraminifer with them can be obtained.'"

"These are the facts, so far as they have as yet fallen under my observation. It remains for future more extended inquiry to determine with certainty their true significance."

The following notes also refer to the Coccoliths:

"I may repeat here, what I announced cursorily in a paper on the Polycystina, read by me on the 10th May, 1865, before the Microscopical Society, and published in the 'Transactions' for that year; that I had also discovered Coccoliths in the Barbadoes and other fossil earths; and Coccospheres as free-floating organisms in tropical seas. Towards the close of the same year, I again found them in abundance in the British Channel.

"In my previously published observation on the nature of the 'oozy' deposits of the Atlantic, I have dwelt on the striking difference in character that exists between the immediate surface-layer of the sea-bed, and the stratum beneath; and have pointed out why all *living* animal structures must necessarily be confined to this surface-layer. Although it is now too late to put the matter to the test—and a decisive opinion on the subject can only be formed by an analysis of the deposits the moment they are obtained—it would seem probable that the preponderance of perfect structures, as compared with their exuviæ or débris, is to be accounted for on the supposition that, inasmuch as the former occur on the surface, whilst the latter become the sub-stratum, this preponderance when observable under the microscope, presents itself as a portion of the surface-layer or the sub-stratum happens to be examined. It is quite certain, morever, that even in the case of the preserved specimens of deep-sea deposits, portions picked out from different levels present different relative quantities of these and other structures also.

"As will be shown on a future occasion, some of the free-floating Coccospheres are oblong. It may be mentioned also that although I have here noted $\frac{1}{830}$th of an inch as the largest observed size, very much larger specimens must in all probability exist, inasmuch as I possess mounted specimens of Coccoliths which themselves measure $\frac{1}{900}$th of an inch across their longest diameter."

Dr. Wallich objects to the establishment of a new grade of

life with the title Bathybius, as not being as yet warranted by the evidence.

On Noctiluca Miliaris. Reply to Dr. Carus. *Archiv für Anat. u. Phys.*, 6th part, 1868.

The Crustacean Fauna of the Salt Marshes of Northumberland and Durham. By G. S. Brady. *Nat. History Trans. of Northumberland and Durham.*—This paper contains descriptions of new species, and is a valuable account of a mixed fresh-water and marine fauna.

Contributions to the Study of the Entomostraca. By G. S. Brady. No. IV. *Annals and Mag. of Nat. Hist.*, Jan.—This is one of a valuable series on which Mr. Brady is at work.

Discovery of Embletonia in Victoria Docks. By W. Kent.—Mr. Kent has described and exhibited at the Zoological Society a new species of Embletonia, *E. Grazii*, from Victoria Docks, where it occurs with *Mysis vulgaris*, *Cordylophora*, and other interesting forms. Mr. Kent has also obtained a new Polyzoon from this locality.

PROCEEDINGS OF SOCIETIES.

Dublin Microscopical Club.

15*th October*, 1868.

Rev. E. O'Meara exhibited a specimen of *Toxonidea gregoriana*, found in a gathering made at "Ireland's Eye." He also showed *Fragillaria mesolepta*, Heiberg, found at Malahide, and *Fragillaria æqualis*, Heiberg, from the oyster-beds at Malahide.

Dr. John Barker exhibited a new and remarkable form of Penium. This was rather large, elongated, somewhat attenuated at the centre, and tapering slightly towards the rotundato-truncate ends; it was, moreover, particularly characterised by the cell-wall possessing a number of superficial conspicuous, rather coarse striæ, running in a spiral direction; these somewhat interrupted at a number of annular rib-like projections, varying in number; these projections most numerous towards the upper third of each segment. This very marked and noteworthy form had been taken in a gathering made on a recent excursion to Connemara; but the precise locality Dr. Barker was unfortunately unable to determine. He would propose the name *Penium spirostriolatum* for this species, as conveying the remarkable character which distinguishes the present form from every other Desmid.—Dr. Barker likewise exhibited two forms of *Docidium*, from the same gathering, new to this country; but which, however, pending an opportunity to examine authentic examples of certain Continental forms, it would be premature to consider as undescribed. One of these was slender, sides undulate, contracted just under the ends, which were somewhat dilated. The other was still more slender, sides straight, tapering gradually towards the ends, which presented each two or three minute apiculi at the extreme angles.

Mr. Archer said that he had had an opportunity to examine the three very interesting forms shown by Dr. Barker, all of which were new to his eyes, and, so far as he could make out, the first at least was undoubtedly a new and undescribed species. The *spiral* striæ, which were coarse and somewhat irregular, as compared with those of a Closterium, for instance, were unique; but, perhaps, he might be justified in calling to mind a possibly comparable character as described for a form called by Kützing *Closterium decussatum*. May it not reopen the supposition that a species of Closterium may exist with spiral or, at least, oblique striæ, without being obliged to imagine, with Ralfs, that the decus-

sate appearance is due merely to the condition of mounted specimens distorted by pressure or other causes? If so, the decussate appearance would be due to both surfaces of a normally spirally striated form being simultaneously seen, thus offering diamond-shaped reticulations, as Ralfs suggests ('Brit. Desm.,' p. 220). When Dr. Barker first showed this form to Mr. Archer, they were both momentarily under the impression that the form presented a spiral fibre wound interiorly; but a more accurate examination showed that the striæ were really external. These, with the annular projections at intervals, gave the form a very marked appearance. Still, when viewed under a low power, there is just a possibility that this species might be mistaken for *Penium margaritaceum*, though no two species can be more distinct.—As regards the second (undulate) form shown by Dr. Barker, Mr. Archer ventured to think it must remain undecided whether this might be *Pleurotænium nobile* (Richter) or *Pleurotænium dilatatum* (Cleve). Pending seeing actual specimens he would think it premature to decide.—The third form shown by Dr. Barker was equally certainly new to this country, but also equally hard to decide upon. It seems possibly the same as *Docidium sceptrum* (Kütz.).

In connexion with these forms Mr. Archer, whilst admitting the arrangement of the endochrome was seemingly a beautifully constant, and doubtless also an important character, would here desire to remark that Professor de Bary seemed to have somewhat misunderstood his (Mr. Archer's) views on the subject, most likely from his not having clearly expressed them. All Mr. Archer would venture to propound was that he thought that matters were not as yet quite ripe for the adoption of the genus Pleurotænium, and the last form drawn attention to by Dr. Barker seemed to bear out this view for the present. This was doubtless a species of *Docidium* (Bréb.), but would just as doubtless be *à priori* placed in the genus *Pleurotænium* (Näg.) by those who adopt that genus. But in the first specimens he had ever seen, when the gathering was fresher than now, there was just as little evidence as on the present occasion that the endochrome occurred in longitudinal parietal bands; nay, it rather appeared to form an axile irregularly arranged mass. But on this point, touching this form, he would rather trust to its re-discovery and examination in a still fresher state. But further, as bearing on this genus (Pleurotænium, Näg.), that fine species, *Staurastrum tumidum* (Menegh., Bréb., Ralfs, Kütz. et auct.) is on all hands, even by those who adopt the genus Pleurotænium, placed in Staurastrum; yet it appears to be as truly a Pleurotænium (in that its endochrome forms parietal bands, often, however, with numerous other granules obscuring this structure), as is de Bary's *Pleurotænium turgidum* (*Cosmarium turgidum*, Auct.), or even as the common *Docidium Ehrenbergii*. This being the case, it is not impossible that certain other of the rarer forms, now referred from external figure to other genera, may be strictly referable to Pleurotænium. Mr. Archer

would not, however, wish it to be thought that in these remarks he was contending against the genus Pleurotænium, which probably would hereafter be found to be a good and natural one, but only that our experience seems not yet sufficiently advanced for its reception. There can be no doubt but that the configuration of the endochrome is very constant and generically, if not specifically, characteristic in these and many others of the simple Algæ —such, for example, as the genera Mesotænium, Cylindrocystis and Spirotænia, Zygnema, Spirogyra, Drapernaldia, Mesocarpeæ, Œdogonieæ, &c.

Mr. Tichborne exhibited a slide of Platinocyanide of Thallium, as a polariscopic effect. One peculiarity of this salt is that it shows, when viewed by polarized light, appearances similar to starch-granules viewed under the like circumstances. This was well shown by the specimens now brought forward.

Mr. Archer exhibited specimens of a fine new Staurastrum from Connemara, remarkable for being probably the very largest of rayed or armed forms yet found in Europe, the largest of the Ralfsian forms being probably some $\frac{1}{350}''$ in expanse, while this reached $\frac{1}{300}''$ from tip to tip of the radiating arms, ten of which, beautifully toothed or serrated and notched at the end, extending in the end view like a wheel, presented a very handsome and striking appearance. Mr. Archer trusted to give, on a future occasion, a detailed description of this species, which he would name *Staurastrum verticillatum*.

Mr. Woodworth showed some excellent transparent photographs of microscopic objects, prepared by himself, for the magic lantern, and which were justly much admired.

19*th November*, 1868.

Mr. Archer desired to record the occurrence of *Micrasterias crux-melitensis* (Ehr.), Ralfs, in the gatherings made in Connemara, and for the first time discovered in Ireland; it had been found by him in the material exceedingly sparingly. He had made a previous acquaintance with it from specimens obtained from Scotland and from Wales. It seems to be a tolerably widely distributed form in Europe, and it was met with by Dr. Wallich in Bengal; but yet it appears to be always very sparing.

Rev. E. O'Meara exhibited specimens of *Surirella turgida*, found in considerable abundance in a gathering from Lough Neagh, not far from Lurgan. He was not aware that this form had been found anywhere but in Lough Neagh. He showed also forms of *Stauroneis acuta*, found sparingly in Lough Neagh, and also in a pond near Armagh. He further directed attention to *Tryblionella Victoriæ* (Grunow), found in gatherings from Lough Neagh, and from the Ulster canal near Poyntzpass. Concerning this species Grunow remarks—"I have observed this species in abundance amongst algæ of the *Victoria regia* tank in Kew Gardens, at London, and conjecture that it has come in with the latter from

tropical America, for I find it described neither by Smith nor by any other English author." The conjecture of Grunow, perhaps not unreasonable under the circumstances, becomes untenable from the fact of the form having been discovered in two localities altogether removed from the suspicion of foreign influences.

Professor E. Perceval Wright exhibited preparations illustrative of the minute structure of a new genus and species of Gorgoniadæ, which he designated *Keratoisis Grayii*. This species had been dredged in deep water off the coast near Lisbon, and had been given to him for description by his friend Professor Bocage. The so-called "barky layer" (cœnenchyma) is well developed, and contains a large number of calcareous spicules, which form a roughened tissue over the whole surface of both stem and polyps. The spicules forming the calyx around the polypes are large and fusiform, and some nine or ten very long ones form a sheath around the polyp, projecting considerably beyond it when the polyp is contracted. Those in the barky layer are much smaller, being longer than broad, and slightly irregular. None like them are figured in Kölliker's 'Icones.' A third form of spicule, of the same general type as that met with in *Isis hippuris*, is met with in the body-layer of the polyp.

Dr. John Barker drew attention to a copious supply of an alga, which appeared to be the *Cœlosphærium Kützingianum* (Näg.), the remarkable circumstance in connection with these specimens being that the clusters or groups of cells forming the families, besides being more or less lobate or constricted, or otherwise presenting irregular departure from the orbicular form, likewise showed a distinct but very gentle independent motion of an oscillatory or indeterminate side-to-side character, and not seemingly attributable to outward causes, and in some measure giving the idea of the existence of cilia; but, as might be anticipated, no such was evident on the closest inspection. It would be hard to say to what this agitated, slow, and indeterminate movement could be attributed. Dr. Barker was himself inclined to see in the lobate or more or less constricted outline of the families or groups a certain amount of spiral arrangement of, as it were, secondary accessions to a primary family, obscurely resembling that of a Rotalina, and hence pointing to some distinction from Cœlosphærium.

Mr. Archer was disposed to think the plant now shown by Dr. Barker could be none other than *Cœlosphærium Kützingianum* (Näg.), notwithstanding that Nägeli seemed to think it necessary, in depicting his plant, to begin by drawing an absolute circle, as if with a pair of compasses. For some time after Mr. Archer had seen Prof. Nägeli's figure he had been wondering why we did not encounter it in our waters; but it by and by occurred to him that the plant with which he had been tolerably familiar, though it does not appear to be frequent, could be none other than the Cœlosphærium of Nägeli. He was not himself able to recognise any spirality in Dr. Barker's specimens, and in this opinion Mr.

Crowe coincided, but rather looked upon the lobate outgrowths as simply departures from the globular typal form due to the excessive activity of the self-division of the constituent cells taking place at certain points of the group. The individual cells were, indeed, mutually in closer proximity than Nägeli depicts—a circumstance probably assisting to bring about the departure from the simple globular figure of the family or group. The slow vibratory movement was a curious circumstance, seldom seen in objects so large as these specimens, and one upon which he could not venture to offer an opinion.

Mr. Crowe exhibited specimens of Labrodagnite.

Mr. Archer exhibited specimens taken in Co. Tipperary of *Sphærozosma filiforme* (Ehr.), Auct. This minute and well-marked little form appears to be *very* rare; and, except very sparingly by Rabenhorst, has not seemingly been met with since its original record by Ehrenberg. It is at first glance well distinguished from *Sphærozosma excavatum* by the elliptic form of the segments, separated by an acute constriction and its larger size, and from *Sphærozosma vertebratum* by the double processes (not single as in that species) connecting the joints. It is distinguished, too, by a different colour, not being of the same bright green, and by its smaller size. Examples of both the common forms, along with *Sphærozosma filiforme*, Mr. Archer exhibited side-by-side.

Mr. Archer likewise drew attention to a form of *Gonatozygon Ralfsii* (de Bary), from the same gathering, presenting the peculiarity that the little roughnesses characteristic of this species (and of *G. Brébissonii*), which ordinarily give little more than a granular appearance to the surface, were here extended into short vertical, acute, almost spine-like prolongations, giving the joints a somewhat remarkable appearance. These little processes were of somewhat different lengths, and seemed to give this form a claim to be regarded as a near approach to a *spinous filament*. It would be in the recollection of the Club that Mr. Archer had once the opportunity of showing at a former meeting some specimens of this species from Yorkshire, which he owed to the kindness of the Rev. Prof. Gagliardi, in which the roughnesses were reduced to a minimum, giving a simple dotted appearance, thus showing the amount of variation this species seems subject to in this regard. Those specimens were, however, in a barren condition; but the present now exhibited showed a number of conjugated examples, and in that condition it quite accorded with the usual form in all respects.

Dr. Barker showed *Desmidium aptogonum*, new to Ireland, taken on the recent occasion of his and Mr. Archer's visit to Connemara. This is a form which has never yet turned up near Dublin. The present was the triangular variety; both seem to be rare and partially distributed, but the triangular form appears to be (like the triangular form of *D. Swartzii*) more common than the quadrangular. The triangular form of *D. Swartzii* is, however, per-

haps the very commonest and most abundant of filamentous desmids; whilst *D. aptogonum*, as mentioned, is a rare form in either of its varieties.

17th December, 1868.

Dr. John Barker exhibited a Chytridium, or some allied organism, attacking a specimen of *Closterium lunula*, endogenous in habit, but perfecting its growth externally to the Closterium. Pending want of information as to the mode of exit of the zoospores, whether by one or several pores, and whether these are furnished or not with a lid, no very satisfactory opinion could be arrived at as to its exact location or identity. The present specimens, however, presented the character that the internal lower portion, from whence seemed to emanate root or mycelioid processes, was connected to the external and upper portion by a slender isthmus-like tubular junction, and through this, in the progress of development, passed up the granular contents from the lower cavity, leaving it seemingly empty, preparatory, evidently, to becoming changed into zoospores. It seemed, therefore, that this might be identical with *Chytridium lagenaria* (Schenk).

Mr. Archer brought forward a new Rhizopod, taken near Carrig mountain, which formed a second species in Carter's genus, Acanthocystis. At a first glance this form might possibly be mistaken for an ovum of some rotatorian, and he had for a little been in some doubt as to its true nature. However, even before the pseudopodia made themselves apparent, he had fully made up his mind that it was no doubt a congener of Carter's fine and very marked species. Even without seeing the pseudopodia extended, the slender acute spine, which stood out from the periphery, being often pointed in various directions, and frequently deciduous, as well as the outer covering, presenting a number of those short slender spicules, lying in the direction of a tangent, similar to those of *A. turfacea*, at once decided that this was no rotatorian ovum. The body contained numerous minute, though variously sized, colourless granules; the pseudopodia, which the creature is somewhat diffident in extending, are slender, but present a few minute granules moving up and down. This is a much smaller form than *A. turfacea*. It will be seen, then, that it is distinguished from that species by its smaller size and its short acute spines of equal length (not elongate, and in two sets of different lengths, and cleft at the apices), and by the seeming constant absence of chlorophyll-granules (whereas in *A. turfacea* these are nearly constantly present). There is by no means a want of resemblance to Perty's form, called by him *Actinophrys brevicirrhis* ("Zur Kenntniss kleinster Lebensformen," p. 159, t. viii, fig. 7); and there is, perhaps, just a possibility that it might really be that form, supposing Perty to have overlooked the spines, taking them (in examples in which the pseudopodia themselves were not extended) for the

actual pseudopodia. But as Claparède and Lachmann record the occurrence of a form which they identify as *Actinophrys brevicirrhis*, Perty, as frequent near Berlin ('Etudes sur les Infusoires et les Rhizopodes,' p. 450), this supposition appears not at all tenable, as it is most unlikely that the whole three observers could have fallen into the error of taking the present form for a member of the genus Actinophrys at all. Nothing, indeed, could be more sure than that this new form, now exhibited by Mr. Archer, appertained to Acanthocystis, and there seemed as little doubt that it was an undescribed species. Mr. Archer would postpone giving a description of this pretty little Rhizopod, as he hoped to be able shortly to do so, accompanied by a figure, and would meantime content himself by naming it after Perty, *Acanthocystis Pertyana*, as commemorative of his labours; although, for the reasons mentioned, it can hardly be identical with his form, notwithstanding a certain amount of resemblance.

Dr. Moore exhibited a Sirosiphon, so intimately intergrown with *Jungermannia concinna* as almost to lead to the idea that they might be genetically related—a state of things rendered, indeed, out of the question by reason of the essentially distinct nature of the cell-contents in each, not to speak of the decided lichenous nature of the former.

Mr. Crowe exhibited sections of "Lough Neagh petrified wood" and of Carrara marble.

Mr. Archer exhibited a new Staurastrum, from Galway, characterised by the possession of a number of crenatures, seen in front view bordering the outline, which considerably resembled that of *Staurastrum orbiculare*, both in contour and size. These crenatures were due to a number of short truncate, compressed, somewhat emarginate processes, the upper six of which in figure were comparable to that of an open book made to stand vertically. He showed the end view, as seen in an empty half-cell, which presented a very pretty appearance, and which rendered apparent the form of the crenatures adverted to. He would, however, defer a proper detailed description till another opportunity, and give this species the name of *Staurastrum maamense*, now merely drawing attention to this curious kind of ornamentation, due not to spines, nor to "pearly" granules, but to thin erect processes, bent vertically at an obtuse angle, thus not throughout in the same plane, and these somewhat emarginate at the upper edges.

Rev. E. O'Meara submitted to inspection a slide, containing many interesting diatomaceous forms, dredged from a depth of 2000 fathoms in the Gulf Stream, lat. 47° 3′ N., long. 23° 21′ W. This slide had been given to him by Professor E. P. Wright, and was portion of some deep-sea soundings taken by Commodore Chimmo, of the Gannet, which had been submitted to Dr. Wright by Professor Haughton, for a report thereon. He invited special attention to a form belonging to the genus *Euodia*, which in outline and sculpture presented such divergence from the two forms

of this genus described by Ralfs in 'Pritchard,' as seemed provisionally, at least, to justify a distinct designation. This form could not be confounded with *E. Brightwellii*, in which, according to Ralfs' description, the lower margin is concave; whereas in the present case the outline of the lower margin is convex, in which particular it resembles *E. gibba*. Compared with this latter the form in question is relatively broader, the outer margin being regularly semicircular. In *E. gibba* the ends are somewhat produced. In this case it will be observed that towards the extremities the dorsal margin bends inwards towards the ventral. In the course of the examination several examples were met with, and they ever presented the same outline. The sculpture of the valve, as in the other two forms of the genus, is punctate, but instead of being arranged in concentric lines, as is the case with *E. Brightwellii* and *E. gibba*, the puncta are dense, and towards either extremity arranged in parallel lines across the valve; towards the middle it was impossible to observe satisfactorily the arrangement of the puncta. This form Mr. O'Meara proposed to name *Euodia Chimmoana*. In connection with the form he also took occasion to refer to a remark of Ralfs, who doubts "whether Hemidiscus be distinct from Euodia, since the only distinction seems to be the marginal nodule of the former—a character perhaps overlooked by Professor Bailey." In the numerous specimens which came under notice there was no appearance of a nodule in the ventral margin—a fact which confirms the accuracy of Bailey's description of *E. gibba*.

Professor E. Perceval Wright exhibited mounted specimens of the Polyps of *Tubipora musica*. The animal of the Organ Pipe Coral has been up to the present moment almost unknown. The figures of its structure, as given by Quoy and Gaimard, have been copied from book to book, and the details of that structure, as given by these same authors, are, to say the least, meagre and unsatisfactory. Dr. Wright looked for a long time in vain for living specimens of this Alcyonarian in the Seychelles, dredging for it in deep and shallow water; and while feeling sure it was not far off (from the fresh-looking specimens that very frequently came ashore), searching for it without success, until an accident revealed its peculiar *habitat*, and then it was found in great quantities. One day, during the prevalence of a "Grande Marée," while wading up to his waist on the edge of the coral reef off the north-west side of Ile Curieuse, his foot sunk into a substance which conveyed to him quite a different sensation from either the slippery Alcyonaria or the sharp-edged brittle Zoantharian Corals, and gathering up some of it with a landing-net, he found he had put his foot upon a mass of *Tubipora musica*. From that time he had no difficulty in finding any quantity, nor in coming to the conclusion that the Tubipora lived as a parasite on the Zoantharian Corals, just at the borders of low water. The observations made then he hoped to give in detail elsewhere, even though on his return home he found that Professor Kölliker had been

engaged in the examination of spirit specimens from the Fiji Islands, at present it is only necessary to state that the *Tubipora musica* is an Alcyonarian; that it belongs to the section of the Alcyonidæ; that it is very well entitled to form a sub-family, Tubiporidinæ, distinguished by the peculiar mode of growth by which the external tabulæ are formed, and by the peculiar spicules (calcareous) found in the ectodermic layer of both tentacles and body; that the tube is formed of consolidated spicules, which are of two sorts, and are not consolidated in the upper part of the tube; that there is no communication between the Polpys; that the tabulæ take their orgin as flat buds from the disk of the Polyp, and that in all probability this same bud is also the starting-point of each new zooid form of polyp.

Royal Microscopical Society.

January 13th, 1869.[1]

The President in the chair.

G. A. Amos, Esq., and the Rev. T. R. Jones, were elected Fellows.

A paper was read by Dr. Charlton Bastian "On the Mounting and Tinting of Animal Tissues." In speaking of the mounting of sections of liver and kidney, the author stated that, on the whole, he preferred a solution of Canada balsam in benzole, for the preparation of which he gave the following directions:

Some Canada balsam must be carefully heated in a shallow pot for a certain time, so as to drive off as much as possible of the turpentine which it may contain; then it should be poured into a small bottle, and sufficient benzole added for the solution of the balsam. After all the balsam has been dissolved, the solution should be filtered through very thin filtering-paper into a stoppered bottle, and so kept in store, what is required for immediate use being poured into one of Highley's drop-bottles. The preparations may then be mounted in this solution in either of two ways:—1st. The section cut from a hardened organ is allowed to remain in a watch-glass with some spirits of wine for two or three minutes, then a drop of carbolic acid having been placed upon the glass slip on which the specimen is to be mounted, the section is taken from the watch-glass on the tip of a small scalpel, its dependent edge brought into contact for a moment with a piece of clean blotting-paper, and then gently laid on the surface of the carbolic acid. This renders a thin section perfectly transparent in about half a minute. The superfluous carbolic acid should then be got rid of by tilting the slide and applying a small piece of

[1] In the 'Journal of the Royal Microscopical Society' this meeting is erroneously reported as having occurred Dec. 13th. We may also correct another error in the same journal, p. 62, in which a meeting is stated to have taken place as far ahead as 1968.

blotting-paper to the edge of the specimen; this done, two or three drops of chloroform should be poured over the section, and allowed to remain in contact with it about one minute; and during this time the specimen may be properly arranged in the centre of the slide. A slight tilting of the slide then suffices to get rid of the chloroform, when, before the specimen becomes dry, two or three drops of the solution of Canada balsam in benzole should be poured over it from the drop-bottle, and the covering-glass then applied. The mounting is thus finished, and the specimen only requires a certain amount of protection for a time till the balsam in which it is mounted has become hardened. 2nd. The section having been placed in the watch-glass with ordinary spirits of wine for about a minute (merely to wash it), is then removed to another watch-glass or small covered capsule, containing absolute alcohol, and allowed to remain in this for five minutes. It is then to be removed, and placed on the slide on which it is to be mounted. The superfluous alcohol having been got rid of, it is covered with one or two drops of benzole for about a minute (which renders the section as transparent as if it had been placed in carbolic acid), and then, this having been tilted off, the additional steps are as before, viz. Canada balsam in benzole from the drop-bottle, followed by the application of the covering glass.

The latter method the author preferred for mounting sections of the liver.

Another method for mounting very delicate tissues consists in mounting the specimen in a very weak aqueous solution of bichromate of potash—about one of the bichromate to 1000 parts of water. In using an aqueous medium such as this, however, we are placed, as it were, at the mercy of the cement we employ. If this be not good, we may, at the time when we most regret it, find a valuable specimen ruined, owing to some crack or imperfection in the border of cement having permitted the water to evaporate. Incomparably the best cement is one which is much used in Germany, consisting of a solution of gum-mastic in chloroform, thickened with nitrate of bismuth. This may be easily kept at the proper degree of consistence by the addition of a few drops of chloroform from time to time. It may be used also for the specimens mounted in glycerine and carbolic acid. It does not run in, it hardens quickly, and when thoroughly dry has a stone-like consistence, and is not liable to crack.

With regard to mounting sections of brain and spinal cord, after speaking of the various substances employed as damaging the specimens by atmospheric changes, he stated that the most favorable results, independent of atmospheric conditions, might be brought about by immersing the section for about ten minutes in absolute alsohol diluted with 8 per cent. of water, then placing it upon the glass slide, and before it became dry pouring over it two or three drops of pyro-acetic spirit, in which it was allowed to remain from $\frac{1}{2}''$—$1''$, then tilting this off, and replacing by chloroform. The effects were then watched, as before, under the mi-

croscope, and, at the suitable time, the solution of Canada balsam was added, and the covering-glass applied. There were two great disadvantages in connection with specimens prepared in both these ways: one was that the section itself was more or less obscured by minute granules of balsam, which had been precipitated out of its solution in a molecular condition by contact with the specimen; and the other, that sections so prepared did not retain their characteristic appearances more than about six weeks or two months; after that time they began to grow uniformly transparent, and were no longer of any use. The first disadvantage was obviated by using the solution of Canada balsam in benzole, instead of the balsam in chloroform, which gives a preparation similar in all other respects, but free from the defacing granules of molecularly precipitated balsam. The last disadvantage, however, in spite of all attempts, still remains; the specimens so prepared have only a temporary value, and will fade after from six weeks to two months. But the operator must acquire a certain amount of experience for himself before he will be able to use this method with success; and unless his reagents be all perfectly pure and fresh, he will almost surely fail to secure satisfactory results.

He also recommended for rapid tinting bichloride of palladium. Another method of double tinting was to place the section, but without chromic acid, in a solution of nitrate of silver (1 : 600) for five or ten minutes; taken from this, washed in pure water for a minute, and thence transferred to the acidulated gold solution as before. After the reduction of the gold by formic acid, the specimen may be mounted in the solution of Canada balsam in benzole, and then exposed to light, in order to bring about the complete reduction of the silver. When this has been done it will be found, on microscopical examination, that the epithelial elements are for the most part stained of a brownish-black colour by the reduced silver, whilst the intervening fibrous tissue elements and the walls of the vessel are stained purple by the reduced gold. The two kinds of tissue elements seem to exercise a sort of elective affinity for the different metals.

At the conclusion of a short discussion on this paper Dr. Lankester requested information from the President as to the most convenient method of bringing before the Society the question of the publication of the transactions of the Society in connection with the new journal. He said he thought the subject was one that affected the dignity and usefulness of the Society, and he considered that the change which had been lately made ought to have been done by a vote of the Society, and not in an unauthorised way by the Council.

The President stated that the Council had power to act as they had done, and that the present was not the time to discuss the question alluded to by Dr. Lankester.

After consultation with the Secretaries, Dr. Lankester gave notice that at the next Annual Meeting he should move that the

words in Bye-law 56, "and of such other matter as the Council may determine," be omitted. He wished to confine the Council to the publication of the transactions of the Society alone.

February 10th, 1869.

This being the Annual Meeting of the Society, the Treasurer's report was read; also the reports of the Cabinet and Library Committee. The President then delivered his address. He first gave a short biography of three of the members of the Society who had died during the preceding year. They were Nathaniel Bagster Ward, Esq., F.R.S., formerly Treasurer of the Microscopical Society of London; William Bird Herapath, M.D., F.R.S., of Bristol; and Henry G. Wright, M.D., of London. The other deceased Fellows, who were only named, were Henry Lidden, Esq., of Rochester; John W. Griesbach, Esq., of London; William Ralph Milner, Esq., surgeon, of Wakefield; and Henry Smith, Esq., of Clapton. The following remarks with regard to the new journal were made:

"The Society was informed in my anniversary address, delivered last year, that the Council had decided upon terminating the agreement for the publication of its proceedings and transactions in the 'Quarterly Journal of Microscopical Science.' In conformity with this intention the connection of the Society with that journal ceased with the publication of the last October number.

"In devising fresh plans the following points had to be considered:

"1st. Whether the proceedings and transactions of the Society should be issued by themselves, or in connection with similar matter derived from other sources.

"2nd. Whether the publication should be monthly instead of quarterly, as heretofore.

"3rd. If the Society should hand over its papers and proceedings for publication in a journal that was not entirely its own property, in what way its legitimate influence and control might be preserved.

"4th. The best means of obtaining for the Society some advantage proportionate to the value of the matter it might place at the disposal of a publisher, and for its action and influence in securing and promoting the sale of any publication with which it might be connected.

"After much deliberation it was considered that the interest of the Society would be best promoted by connecting the publication of its own transactions and proceedings with a record of the principal microscopical researches laid before other societies, or embodied in works not generally accessible. It was also thought desirable that the publication should be monthly, as ensuring the speedy communication to the scientific world of new facts and discoveries contained in papers read before the Society.

"Your President and some members of the Council would have preferred that the Society should issue its own proceedings and transactions in a handsome form, and without the addition of any other matter; but they did not see their way to dissociate themselves entirely from all arrangements that had been made by their predecessors, and which had been many years in force.

"For a long time the Fellows had been accustomed to receive, in connection with their own proceedings, microscopical information drawn from various sources, and inquiries led your Council to believe that any changes involving a diminution of information would be repugnant to the wishes of the majority of the Fellows. They therefore endeavoured to make arrangements by which the Society would be a clear gainer, in the quantity as well as in the quality of the matter supplied.

"There was another reason which influenced them in this decision, and that was a desire to establish useful and friendly relations with other excellent Microscopical Societies, both in the metropolis and scattered throughout the country. The mass of matter brought before all these bodies would preclude the possibility of combining it all in one publication of reasonable dimensions, but some record might be given of the most interesting facts contained in their papers, and a journal sanctioned by the Society, and thus bringing to a focus information that had hitherto been so scattered as to be practically beyond the reach of most students, would render important service to the scientific world.

"In reference to the third point of inquiry, it was deemed essential that the Society should have a copyright in an important portion of the title of any publication in which its transactions &c., might appear, and that the proprietors of the journal in which they were published should only be at liberty to use such portion of the title so long as an agreement to that effect between him and the Society might subsist, and that the Society should have a voice in the appointment of an editor, whose duty it would be to place himself in intimate communication with it and to promote its interests.

"It was thought proper that the proprietors of the 'Quarterly Journal of Microscopical Science' should have ample opportunity for making any offer to the Society complying with the preceding requisitions; but as they positively declined, attention was turned in other directions, and an arrangement was made with Mr. Robert Hardwicke, in conformity with all the Society's stipulaitons, for the issue of the Monthly Journal, to commence on the 1st of January, 1869, to be edited by Professor Lawson, M.D., and to contain, in addition to the matter furnished by the Society, an ample digest of British and Foreign Histological Research and Microscopical Intelligence. Two monthly parts of the new publication have now been issued.

"The cost to the Society for 450 copies of the new Journal will be £20 per month, and additional copies will be charged 1s. each. By this arrangement the Fellows will receive about twice as much

matter in the course of each year as was supplied under the late arrangements, and they will have a monthly publication without materially adding to the expense heretofore incurred by the Society."[1]

The address then proceeded to give an abstract of the papers read during the past year at the Society's meetings. The following paragraph with regard to the Quekett is a graceful admission on the part of the President that the original apprehensions with regard to the Quekett Club were entirely unfounded:

"In the first year of my presidency a Microscopical Society was founded, under the presidency of Dr. Lankester, with the title of the 'Quekett Club.' This society has progressed most satisfactorily, and is progressing to increasing usefulness, under the presidency of Mr. Durham."

For the first time in its history the Society has come to a standstill. The President says—

"At the last year's anniversary our numerical strength was 452. During the year the number of elections have been 21. We have lost 7 by death, 7 by resignation, and 7 expelled. Our present numbers are therefore 452; of these 93 are compounders. Thus the Society is flourishing; but its annual income is too near to the necessary annual expenditure, and all disbursements will require a careful consideration of the Council, so that our prosperity may continue."

The thanks of the meeting having been given to the President for his address, Dr. Lankester rose to propose the alteration of Bye-law 56, of which he had given notice at the previous meeting. He said, "Mr. President, I should have been glad that any other member of the Society should have proposed this resolution rather than myself, as I am afraid my motive for doing so will be liable to misunderstanding. My reason for proposing the alteration of Bye-law 56 has arisen out of my anxiety that the Society at large should have an opportunity of expressing its opinion on a subject alluded to by the President in his address—the establishment of a new 'Journal of Microscopical Science' in connection with this Society. I should have been glad could your opinion have been obtained directly on this subject, but as the bye-law in question gives the Council the power of not only publishing the 'Transactions' of your Society, but of "such

[1] Since the above address was delivered, the following notice has been issued to the Fellows of the Society:—"By the new arrangements made for the publication of the Society's Proceedings and Transactions in the 'Monthly Microscopical Journal,' you will receive in the course of the year about twice the quantity of matter supplied upon the old system, but the expense of postage is necessarily increased. I am therefore directed to inform you that on its issue at the commencement of each month, a copy of the 'Monthly Microscopical Journal' will be ready for delivery, at the Society's rooms, to any one whom you may authorise to receive it, or it will be sent to you for twelve months, by post, if you will have the kindness to give me directions to that effect, accompanied by two shillings' worth of postage stamps."

other matter" as they "may determine," I was informed that the only way of bringing the subject before you was to submit to you a resolution, involving the omission of those words in the bye-law giving them the power of publishing your 'Transactions' with any other matter they might wish. Without immediate reference, then, to the object I have in view, I would call your attention to the extraordinary power given to your Council by this bye-law. There is nothing here to prevent them from publishing your 'Transactions' in a daily paper, and committing you to any religious or political opinions they might hold, on the ground that it was "other matter," which they had the power to determine. I do not say that any Council you would choose would thus act, but it is nevertheless an extraordinary power to give to a Council; and it is on the ground of this bye-law that your Council have ventured to mix up your 'Transactions' with a journal called the 'Monthly Journal of Microscopical Science.' The danger of this clause in the bye-law is, I think, fully demonstrated by the fact that I have several times requested the Council to bring before the Society the subject of the separation of your 'Transactions' from the journal which I have had the honour to edit now for sixteen years. In answer to my request that the subject should be brought before you as a body, Mr. Slack, your Secretary, told me that no Council would submit to the dictation of a Society. (Mr. Slack—"I deny that statement altogether.") I am glad to find that I misunderstood Mr. Slack, and that he evidently thinks the subject ought to have been brought before the Society. My only object in making this resolution to-night is to have an expression of your opinion. As one of the earliest members of your Society, as one of your former Presidents, and as a member of your Council for eighteen years—in fact, till your recent bye-laws excluded the former Presidents from being members of the Council—and with my distinguished friend, Professor Busk, one of the editors of your 'Transactions' for sixteen years, I trust you will allow me to make to you some observations on the recent change you have made in the publication of your 'Transactions.' When the question was mooted, more especially by your late President, Mr. Glaisher, as had been previously done by Mr. Farrants when he was President, of publishing the 'Transactions' separate from the journal which I and Mr. Busk edited, I was anxious that an arrangement which had worked so well for the Society should continue. When we first offered to publish the 'Transactions' of the Society with our new journal, now sixteen years ago, the Society then numbered only 150 members, and from that time to the cessation of your connection with our journal every year presented an increase of members, till at the close of our arrangement the number of members amounted to 470. I am sorry to observe, from your President's address to-night, that that success has ceased. He has had the painful task of announcing to you that for the first time in the Society's history there has been no increase of members during

the last year. It was on this ground, and this ground only, that I urged the propriety of the old arrangement. I knew that a large number of members who lived in the country were induced to continue their subscriptions for the sake of the journal. When, however, the Council determined to break their connection with the journal, both the editors and publishers felt that the journal would not suffer. The editors felt that the necessity of publishing papers over which they had no control burdened the journal with matter that was not consistent with a popular circulation, whilst the publishers felt that they were supplying the journal to the members at a price that was not at all commensurate with the value of the Society's contributions. Under these circumstances neither I nor Mr. Busk thought it necessary to come down to your meetings and force on a discussion to which your Council evidently objected. Now, however, that your Council has chosen, not only to select an editor of your 'Transactions' outside your Society, to publish them in another journal, and to subsidize another publisher in opposition to the one who has published them for so many years, I thought that it was due to myself and due to you that you should have an opportunity of speaking and voting on the subject. I have not sought counsel with any one on this subject, and I shall leave the matter in your hands. You have heard to-night what your President has had to say on the subject, and I have no doubt your Council has been actuated by honorable motives, but it is for you to say whether you think what they have done is right in your sight, and likely to conduce to the interests of your Society and the advancement of microscopical science. I for one object to the arrangement of your new journal, in which your 'Transactions' are mixed up and paged with any inferior matter which your new editor chooses to place them in juxtaposition. This I believe is quite unique in the publication of scientific transactions in any part of Europe, and I believe likely to damage the prestige and influence of the Society's 'Transactions,' especially on the Continent of Europe, where imperfect accounts of the proceedings of their own societies in another language cannot be regarded as of any literary or scientific value. I must confess that when the Council determined to cut us adrift I had hoped to see them spending their funds in the publication of 'Transactions' that would become their new title of 'Royal,' that in size and illustration might stand on the same shelves with the 'Transactions of the Royal Society of London.' I know that I am not alone in feeling disappointment in the course your Council have taken. In conclusion, I would say I have no personal feeling in this matter. I have long known your new editor as a laborious worker in the field of scientific literature; with your new publisher I have long been connected, and know him as an honorable and upright man; and if your decision should be to continue your new journal, I am sure it will interfere with no interests of mine, and I heartily wish it all the success it deserves."

After this address, as no one seconded the resolution, Dr. Lankester left the room.

Mr. Glaisher then explained that the Council had given the subject of the publication of the 'Transactions' the most careful and anxious consideration, that Dr. Lankester had never assisted them in their deliberations, and that eventually they had entered into arrangements with Mr. Hardwicke for the issue of the 'Monthly Microscopical Journal.[1] Mr. Henry Slack, F.G.S., Secretary, said he regretted that Dr. Lankester had left the room so hastily, ere there was time to reply to his assertions. He stated that, so far from Dr. Lankester having an interest in the Society, he had been present at but three meetings during the last four years,[2] and that he never recognised the principle of separate publication of the 'Transactions' during the sixteen years in which the 'Transactions' were issued in the 'Quarterly Journal of Microscopical Science,' of which he is the editor. Finally, Mr. Slack read passages from a letter received last year from Dr. Lankester, in which it is urged that the separate issue of the Society's 'Transactions' would bring about the resignation of many of the Fellows, and was therefore not to be thought of.

The following gentlemen were then elected office bearers for the ensuing year.

President.—Rev. J. B. Reade, M.A., F.R.S.

Vice-Presidents.—Jas. Glaisher, F.R.S.; L. S. Beale, M.D., F.R.S.; W. B. Carpenter, M.D., F.R.S.; G. C. Wallich, M.D., F.L.S.

Treasurer.—R. Mestayer, Esq.

Secretaries.—H. J. Slack, F.G.S.; Jabez Hogg, F.L.S.

Council.—Arthur Farre, M.D., F.R.S.; Arthur E. Durham, F.R.C.S.; H. Lawson, M.D.; James Murie, M.D., F.L.S.; Charles Tyler, F.L.S.; Charles Brooke, M.A., F.R.S.; W. H. Ince, F.L.S.; Henry Lee, F.L.S.; Ellis G. Lobb, Esq.; John Miller, M.D., F.L.S.; Major Owen, F.L.S.; F. H. Wenham, C.E.

Wednesday, March 10th, 1869.

Rev. J. B. Reade, President, in the Chair.

Among the presents to the Society, a special vote of thanks was passed to Mrs. Clarke, Whitby, for twelve beautifully mounted slides of the fructification of seaweeds, and to Mr. Collins for a ½-inch object-glass of small angular aperture, constructed, as suggested by Dr. Carpenter, for special use of the binocular.

[1] Neither Dr. Lankester nor Mr. Busk were ever invited to any deliberation of the Society on the subject.—Eds.

[2] Although this statement is not correct, the absence of both Mr. Busk and Dr. Lankester can be easily accounted for, especially when the new bye-laws excluded them, as being Presidents, from a seat in the Council.—Eds.

Mr. Suffolk exhibited and described Muller's new growing slide.

Mr. Slack described a new rotating stage as fitted to cheap microscopes by Messrs. Beck.

Mr. Ince read a short paper by George Gulliver, Esq., F.R.S., "On the Fibres of the Crystalline Lens."

Alfred Saunders, Esq., read a paper "On Zoospores of Crustacea."

Quekett Microscopical Club.

December 18*th*, 1868. Mr. Arthur E. Durham, President, in the chair.—Mr. John Hopkinson read a paper "On British Graptolites," a group of fossil zoophytes exclusively confined to Silurian rocks. After a brief introduction on their geological and geographical range, he entered fully into the structure of the different forms, and gave a concise history of the establishment of the British genera, noticing the various opinions that have been entertained as to their zoological position. The genera were described and grouped into four families. The *Graptolitidæ* were then showed to be *Hydrozoa*, nearly allied in structure, development, and probably in their mode of reproduction, to the *Sertulariadæ*.

In conclusion, it was argued that the existence of hydroid zoophytes in the Silurian seas, and their complete disappearance until a very recent period, could not be explained by the Darwinian theory of the origin of species.

Specimens of thirty species, and diagrams showing the distinctive characters of each genus, were exhibited.

Mr. Samuel Roberts described a new form of micrometer, consisting of a tube mounted on a separate stand, which, when placed at the side of the ordinary monocular microscope, enabled the observer to look down it with one eye, while the other was occupied with the object.

A discussion ensued, and the thanks of the meeting were given to Messrs. Hopkinson and Roberts.

Mr. J. Eldridge presented the club with a quantity of unmounted specimens for distribution amongst the members.

Sixteen gentlemen were elected as members.

January 22*nd*, 1869. The President in the chair.—The President announced that a society, upon the basis of the Quekett Microscopical Club, had been formed at Liverpool with the greatest success; and Mr. M. C. Cooke, Secretary for Foreign Correspondence, informed the meeting that a similar society had been established at Chicago (Illinois), U.S. He also announced that his class for the study of microscopical fungi would be held in a room which Mr. Wheldon had kindly placed at his disposal.

Mr. George read a paper by Mr. Holmes "On a New Form of

Binocular Microscope," in which the author explained the plan by which he proposed to obtain an equal amount of light and an equal angle of vision in each tube. This he illustrated by means of a diagram and instrument.

A discussion followed the reading of the paper.

Mr. W. T. Suffolk read a paper "On some of the Means of Delineating Microscopical Objects," containing a number of useful and valuable hints to the worker with the microscope.

The respective authors of the papers received the thanks of the meeting for their interesting contributions.

The President, in announcing that the Annual Soirée would be held on March 12th, expressed his acknowledgments of the liberality of the Council of University College in placing the building at the disposal of the Committee for that occasion.

The proceedings terminated with a conversazione.

Ten new members were elected.

February 26th, 1869. The President in the chair.—Numerous donations to the cabinet and library were announced.

Mr. James Jordan read a paper "On the Preparation of Rock Sections for Microscopical Examination." By means of an enlarged diagram he successfully explained his method of manipulation, and further illustrated his paper by exhibiting sections of rock in the various stages of the process. The finished specimens were greatly admired.

Mr. M. C. Cooke read a paper on "Burst Spores," and exhibited coloured drawings showing the fungus in its many stages of development.

Mr. Hailes exhibited an earthenware lamp-shade and reflector, of cheap construction, on the principle of the Fiddian lamp chimney.

Mr. Curties exhibited a large collection of coloured drawings executed by Messrs. Draper, Tatem, and Clayton.

The thanks of the meeting were given to Messrs. Jordan, Cooke, Hailes, and Curties, and the proceedings terminated.

Ten new members were elected.

The extra conversational meetings (for the exhibition of objects only), which have been so very numerously attended during the winter months, terminated on the 12th February.

Literary and Philosophical Society of Manchester.

Ordinary Meeting, January 26th, 1869.

R. Angus Smith, Ph.D., F.R.S., Vice-President, in the chair.

"On Microscopical Examination of Dust," by J. B. Dancer, F.R.A.S.

The author stated that he had made some microscopical examinations of dust collected in June, July, and August last, and also

of the particles contained in the rain water after the long drought. He had intended to bring these observations before the Society in a complete form, but has not hitherto found time to do so. He proposed to carry on observations during every month in the year, for the purpose of recording the average amount of solid matter deposited on a given area, and also as far as possible to ascertain the character of the deposits. The observations so far have shown, as might have been expected, that the dust in various localities, at different altitudes, and under other varying conditions, contained particles differing in magnitude, appearance, and quantity for the same superficial area. In every instance molecular activity was abundant, but the animal life was very variable in amount, the largest number of moving organisms being in the dust collected at the lowest points—this was about five feet above the surface of the earth. This dust also contained the largest proportion in magnitude and quantity of vegetable matter. These observations also show that in thoroughfares where there are many animals engaged in the traffic, the majority of the light dust, which when disturbed reaches the average height of five feet, or about the level of a foot-passenger's mouth, consists of a large proportion of vegetable matter which has passed through the stomachs of animals, or which has suffered partial decomposition in some way or other. This is not an agreeable piece of information, but it is a fact. It shows the necessity, in a sanitary point of view, of the streets being well watered before the scavengers are allowed to commence operations; otherwise the light dust is only made to change its locality, and is not properly removed. It is not pleasant to contemplate the possibility of germs of disease being wafted along with this decaying matter and inhaled by those whose condition might be favorable for its development. The author hopes to bring the details of these observations before the Society at some future time.

H. A. Hurst, Esq., read a paper on the "Flora of Gibraltar," in which he remarked on its great richness, comprising, as it does, in an area of about 1½ square miles, 500 plants, being one half of those contained in the 'Cybele Hibernica,' and one third of the whole number enumerated as growing in the British Islands in the last London Catalogue.

Microscopic Section of the Lower Mosley Street Natural History Society.

January 11th, 1869.—Mr. Chaffers presiding.

The minutes of last meeting were read and confirmed.

The following members brought their microscopes:—Messrs. Armstrong, Hope, Chaffers, Hyde, Nash, Wrigley, Jackson, and Wilmot.

The following objects, amongst others, were exhibited:

Mr. Hope—Spiracle of Dytiscus, soldier beetle, scale of eel, &c.

Mr. Nash—Foraminifera, scale of flying fish, &c.

Mr. Armstrong—Whisker of walrus, eggs of house fly, tendon from human hand, deep-sea soundings, &c.

Mr. Jackson—Pith of briar, hard fern spore, &c.

Mr. Chaffers—Parasite of pike, tongue of limpet, tongue of moth, ear of white mouse, &c.

Mr. Wilmott—Tonge of *Limneus peregeri*, parasite of pike, lung of fresh-water mussel, spores of *Osmunda regalis*.

The following contributions were added to the Society's cabinet:

Mr. Armstrong—Hook and spiracle of caterpillar and tracheæ of silkworm.

Mr. Jackson—Spores of *Blechnum boreale*, pith of wild briar.

Mr. Hyde—Pith of elder, section of pine seed.

Mr. Chaffers—Spiracle of moth, forelegs of wasp, and head of sheep tick.

February 8th, 1869.—Mr. CHAFFERS presiding.

Minutes of preceding meeting were read and confirmed.

Moved, seconded, and carried, "That the Section take in the Quarterly 'Journal of Microscopical Science' for this year."

It was agreed that each member should, at the next meeting, bring a slide or slides of the cockroach or cricket, with observations thereon.

Mr. Armstrong to read a paper at the meeting on 8th March; subject left to himself.

Remainder of evening spent by Mr. Aylward and Mr. Chaffers each dissecting tongue of *Helix aspersa*; Mr. Jackson dissecting Dyliscus beetle; Mr. Armstrong exhibiting a series of slides, the garden spider and its dissections; Mr. Willmot exhibiting parasites from *Argulus foliaceus*.

Several presentations were made to the Society's cabinet by Messrs. Armstrong, Hope, Aylward, and Hyde.

February 22nd, 1869.—Mr. CHAFFERS, President, in the chair.

In accordance with the resolution passed at the last meeting, each member brought slides of the cricket or cockroach.

Mr. Aylward—Gizzard of cockroach, head of ditto dissected; head, gizzard, section of gizzard, anipasiter, spiracles, tracheæ, tongue, and eggs of cricket.

Mr. Jackson—Legs and wing-case of cricket; antennæ of Dyliscus.

Mr. Chaffers—Gizzard of cricket; two slides of legs and abdomen of cockroach.

Mr. Nash—Elytron and antennæ of cricket.

Mr. Armstrong—Two cockroaches mounted entire, head and legs of ditto; and gizzard of cricket.

Mr. H. Hyde—Leg of cricket.

Mr. Wilmot—Gizzard of cockroach.

The evening was spent in examining the various specimens, most of which were very well mounted.

March 8th, 1869.—Mr. Chaffers, President, in the chair.

A variety of unmounted objects were distributed amongst the members, Mr. Armstrong showing four mounted slides of a very brilliant beetle (name unknown), viz. the head, elytron, skin, and wing.

The following contributions were made to the Society's cabinet:

Mr. Armstrong—Elytron of beetle.

Mr. Jackson—Spores of *Lastrea Filix mas*.

Mr. Hope—Wing of white plume moth.

Mr. Armstrong presented two large photographs to the Society, *Pleurosigma formosum*, parasite of field mouse.

It was agreed that at the next meeting, 22nd inst., each member should bring a mounted slide or slides of the spider or house fly, with observations upon them.

Mr. Armstrong read a very comprehensive and instructive paper upon the microscope and the various objects open to the study of microscopists, which he illustrated with a large number of photographs of microscopic objects.

He stated there are three essential conditions of efficiency in a microscope—1st, sufficient visual magnitude; 2nd, sufficient distinctness of delineation; 3rd, sufficient illumination; and gave a lucid description of the three essentials, and quoted various appropriate passages from different authors descriptive of microscopic pursuits; also describing the beauties of nature, and how teeming with life every part of our earth is, and how innumerable are the objects suitable for the microscopist; showing forcibly the amount of true knowledge the microscopist may attain by being observant of the objects of nature, since every flower, insect, fruit, and, indeed, every particle of matter, may afford him both knowledge and entertainment, and that the microscopist will discover in what by less observant men are simply considered as domestic pests there are beautiful forms and perfect appliances for performing the various functions of life, as studies for the microscope. He quoted and instanced the *Volvox globator*, animalculæ of various kinds, water-insects and beetles, parasites from animals, birds, and insects, acari, spiders, dissections of insects and plants, instancing the various transformations of insect life, showing how interesting is the life-history of many of our common insects, naming also for the more advanced microscopist the various anatomical preparations, and, lastly, showing how beautiful as objects of study are the Diatomaceæ and Desmideæ, and how truly wonderful is it that in objects so minute there should be so much real beauty and geometrical precision of lines and outline. In conclusion, drawing attention to the various modern appliances and apparatus connected with the microscope.

MANCHESTER CIRCULATING MICROSCOPIC CABINET SOCIETY.
Annual Meeting.

Held 12th January, 1869, at the house of Mr. J. Armstrong, 88, Deansgate, Manchester.

Present—Messrs. Harne, J. Armstrong. Aylward, H. G. Armstrong, Nash, and Hope; also Messrs. J. Hyde, J. H. Hope, and G. B. Armstrong, as friends.

Mr. J. ARMSTRONG in the chair.

Minutes of previous meeting read and confirmed.

The cash account for the past year was read by the Treasurer, examined and passed.

Tender for 'Microscopical Journal.'—Mr. Armstrong explained that only two tenders had been sent in, and those were in the hands of Mr. Aylward, who had omitted to bring them to the meeting. Agreed that the tenderers (Mr. J. Armstrong and Mr. Hope) settle this matter between them.

Election of officers.—For the office of *President*, Mr. Horne and Mr. J. Armstrong were proposed, and the former was elected by a majority of 1.

Treasurer.—Mr. J. Armstrong and Mr. Nash were proposed for this office, and the former was elected by a majority of 2.

Secretary.—Mr. Nash and Mr. Hope were proposed, and the latter was elected by a majority of 2.

Subject for next meeting.—Proposed by Mr. Hope, and seconded by Mr. J. Armstrong, "That the subject for the next quarterly meeting be 'Crystals.' "—Carried unanimously.

The next meeting to take place on 13th April, 1869; place of meeting to be named afterwards.

Proposed by Mr. J. Armstrong, and seconded by Mr. Aylward, "That the quarterly meeting in future commence at 7 o'clock instead of 8 o'clock."—Carried unanimously.

The rest of the evening was spent very pleasantly in viewing the various parts of the "spider," of which all members present contributed slides with descriptions, and in discussing the various and best manner of mounting the same, those of Mr. Horne and Mr. J. Armstrong being exceedingly good.

This meeting terminated at 10.5 p.m.

BRIGHTON AND SUSSEX NATURAL HISTORY SOCIETY.

January 14th.

The President, Mr. GLAISYER, in the chair. A paper was read by Mr. Wonfor, Hon. Sec., "On Flint," in which the various theories respecting its origin, its place in the geologic formation, and its nature, were discussed; after which the utility of the

microscope in geological research was pointed out, and how a new field of geological inquiry had been opened out by the examination of thin sections of rocks, by Forbes, Sorby, and others. While there was no doubt that flint had been formed by the infiltration or deposits of soluble silicates or organisms—such as sponges, corals, &c.—thin sections or chippings of flint revealed under the microscope the presence of sponge, spicules, Foraminiferæ, Xanthidia, &c. That infiltration and deposition of silex held in solution was still going on was seen by the waters of the Danube, which had converted the pillars of Trajan's Bridge into agate, &c.; by the geysers of Iceland and other volcanic springs. Animals and plants also possessed the power of taking up silex and converting it into various organs, as seen in the sponge spicules, the Hyalonema and Euplectella, the Diatomaceæ, and the siliceous cuticles of many plants.

February 11*th*.

The President, Mr. Glaisyer, in the chair. The discussion on "Flint" was resumed; after which examples of the various ways in which silex in flint exhibits itself in nature were shown under the microscope by the following gentlemen:

Mr. Hennah exhibited sections of flint containing seed-vessels and sponge (*Siphonia pisciformis*), "artificial diatoms," a gaseous deposit of silex, obtained by the process described by Professor Max Schultze, on which markings similar to those on some diatoms were seen, and sections of quartz through the optic axis by which the coloured rings were shown. These objects were exhibited under one of R. and J. Beck's new large microscopes, with concentric rotating stage and iris diaphragm, specially lent by Mr. J. Beck for the occasion. Considerable interest was felt in the iris diaphragm, as it was the invention of Mr. J. Brown, a member of the society. This instrument, with the stage, designed to meet a want suggested by Dr. Carpenter, has been pronounced the most complete microscope as yet published.

Mr. R. Smith exhibited thin sections of flint and chert, containing *Xanthidia pixidularia*, corals, sponge spicules, and dendritic oxides, commonly called "moss agates." Mr. R. Glaisyer showed stellate hairs from *Deutzia scabra* and *D. gracilis*, sections of silicified coniferous wood, disintegrated glass exhibiting markings similar to those on some diatoms, and Polycistina from Barbadoes deposit. Mr. J. Dennant exhibited silex found among the ashes of a wheat-stack destroyed by fire, and siliceous cuticles of wheat, Equisetum, Indian corn. Mr. T. Cooper exhibited recent and fossil sponge spicules and gemmules, and diatoms. Mr. Wonfor showed Foraminiferæ, sponge spicules and corals in flint, Foraminiferæ and other organisms obtained from a cavity in a flint nodule, and Möller's diatom type slide, which had been very kindly lent for the occasion by Mr. T. Curteis, of Holborn. This slide was, in the estimation of all who examined it, the most

marvellous example of skilful arrangement and clean mounting they had ever seen.

March 11*th*.

The President, Mr. GLAISHER, in the chair. A paper on "Microscopical Fungi" was read by Dr. Hallifax. Among other points it was shown that since the microscope had become a more perfect instrument the number of known species had been increased from 400 to between 4000 and 5000. This number would doubtless be increased, as many regions were at present unexplored. The ravages they committed among the crops on which men and animals depended was a great inducement for their study, for, as was well known, the cereals, potatoes, vines, hops, silkworms, &c., had been destroyed by their agency. To the scientific botanist and microscopist they offered many grounds of interest: they afforded a striking illustration of the unity which pervaded organized life, for though so diverse in form and characters, they were all resolvable into the same elemental thread-like substance, called *mycelia*, sometimes filamentous in their appearance, at others fitted and consolidated into a leathery consistency. Many interesting problems in connection with their form, propagation, and supposed influence in disease, remained involved. Some of these points had been cleared up; thus, some species, and even genera, had been proved to be only different stages of development of the same fungus, or differences of form resulting from the *nidus* on which growing. Especial attention was called to those attacking the potato and the wheat, while allusion was made to the so-called cholera fungus. The paper was illustrated by a number of microscopical preparations, among which the most noticeable were—

Peronospora infestans, on potato leaf;
Cladosporum herbarum, on stone-crop;
Stilbyum aurantiacum, on stem of sage;
Aspergillus glaucus, on thyme leaf;

Helotium æruginosum, in oak-wood, exhibiting the germination of the spores, and section of mushroom.

MEMOIRS.

Monograph *of* Monera. By Ernst Häckel.

(*Continued from p.* 134.)

Probably this observation furnishes an indication of the reproduction of the Myxodictyum. It is conceivable that these Moner-colonies reproduce themselves simply by single individuals detaching themselves from time to time from the periphery of the Moner-colony. These may then form a new colony, either from the simple individual dividing into several which remain united by the anastomoses of their pseudopods, or by a stronger flow and accumulation of sarcode taking place at certain points (knots) of the sarcode net; and by these peripheral plasma-lumps gradually centralising themselves, and acquiring the individual shape of the central mother-body. Thus, the reproduction of these Myxodictya may take place in the simplest manner without needing to pass into the resting condition, and then this Moner-form would be intimately allied to Protogenes.

But it is also sufficiently probable, on the other hand, that the detachment of the two individuals from the net under observation happened accidentally, and had not the significance of a reproductive act. Unfortunately, I could not further observe this remarkable Moner. For in the attempt to remove it from the shallow watch-glass, in which it was very inconvenient to examine it with a high-power magnifier, to a more suitable stage, unfortunately a considerable portion of the water containing the Myxodictyum ran over the edge, and so the unique specimen was lost.

It must, therefore, be left to future observers to explore more completely the natural history of this wonderful organism.

II.—4. *Protamœba primitiva.*

With Plate X, figs. 25—30.

Those Amœba-like organisms which have neither nucleus

nor contractile vesicle, and which consist throughout their whole bodies of a perfectly homogeneous and structureless mass, are well to be distinguished from the true Amœbæ (Autamœbæ), which always possess a nucleus, and generally also a vacuole, or even a constant contractile vesicle. Such absolutely simple Amœbæ, the simplest which can easily be conceived, occur, for example, as transitional young stages in the development of the Gregarinæ, from whose Navicula-like granular germs they, the so-called pseudo-Navicellæ, are developed. But such entirely simple Amœbæ also occur as independent organisms, persistent in this very simple form, and reproducing themselves—if you please, as "good species,"—and I have proposed in my 'General Morphology' to separate them as "Protamœba," entirely from the true and manifestly much higher organized Amœbæ (Vol. I, p. 133). As I have only casually mentioned the Protamœba in the passage referred to, and besides have published nothing about it, I shall give a short description of this group here, in addition to the Monera which I have just described.

Protamœba primitiva, represented at figs. 25—30, I observed for the first time at Jena, in the summer of 1863, in water which I had brought from a small pond in the Tautenburg forest (opposite Dornburg, on the right bank of the Saal). The bottom of this shallow little pond is thickly covered with fallen decayed beech-leaves, and in the fine brown mud, among the decayed leaves, I found the little Protamœba, the first Moner which I had happened to meet with.

If the *Protamœba primitiva* is immediately transferred to the microscope from the fine mud in which it creeps, and a strong light is brought to bear upon it, it commonly appears as a homogeneous Plasma-ball of 0·03—0·04 mm. diameter. After some time this ball begins slowly to flatten; its diameter increases to 0·06 mm., and, at the same time, its circular outline becomes irregular. Then a blunt cone-shaped or wart-shaped projection soon begins to appear, first at one point, and then simultaneously at several. While this lengthens, stretches, and draws a portion of the remaining mass of the body after it, the irregular roundish outline becomes pear-shaped, or if several pseudopods appear together, star-shaped. There were seldom more than five or six wart-shaped projections visible on the circumference of the disc-shaped flattened body. The projections or pseudopods always remain short and simple. At most their length about equals the diameter of the rest of the body. They never ramify, and two adjacent pseudopods never coalesce

with each other (figs. 25, 26). The motions of *Protamœba primitiva*, the protrusion and retraction of the processes which vary frequently in number, form, and size, though always simple, take place very slowly. In this particular, it differs essentially from the *Amœba limax* described by Auerbach,[1] which is otherwise the most like it of all known Amœba-forms, leaving out of view, of course, the want of a nucleus and of the contractile vesicle.

The whole body of *Protamœba primitiva* is absolutely structureless and homogeneous. There is no apparent difference between a more tenacious outer and a softer inner sarcode mass. Such a difference is perceptible in most, perhaps in all, true Amœbæ. One can usually easily distinguish between the firmer outer layer, which is homogeneous and not granular (Ectosarc), from the thinner fluid inner parenchyma (Endosarc), which is filled with granules. Sometimes these two layers pass insensibly into one another, in which case the Ectosarc becomes always softer and more fluid as it approaches the interior; sometimes both appear pretty sharply defined, so that one can even designate the outer layer as a membrane (Auerbach). In the Protamœba nothing whatever can be observed of this division of the Plasma into Ectosarc and Endosarc, not even on the application of chemical re-agents. Rather is the whole body formed of one and the same similar substance, which is tolerably tough and consistent, and displays the ordinary micro-chemical reactions of albumen (Plasma).

In some Protamœbæ the sarcode mass of the body is entirely clear and hyaline; in others, again, it is obscured by a larger or smaller quantity of colourless dark oleaginously shining granules, insoluble in acetic acid. Most of these granules are very fine, but a few are larger, and of measureable size. The variable number and size of the granules, their complete absence in some, and their abundance in other individuals, is probably dependent, as in the previously described Monera and in the Rhizopoda, on the change of substance, on the larger or smaller quantity of nourishment taken, and the assimilated ingredients.

I did not succeed in directly observing the taking of nourishment by means of the pseudopods in Protamœba. But I could experimentally prove the absorption of small solid particles into their homogeneous sarcode body, by placing a small quantity of very finely divided indigo in the surrounding water. A few hours later, many Protamœbæ had absorbed one or more

[1] Auerbach, "Ueber die Einzelligkeit der Amœben," 'Zeitschr. für Wiss. Zool.,' 1856, vol. vii, p. 412, Taf. xxii, figs. 11—16.

indigo grains into their interior. Probably the above-mentioned fine grains were at least in part also drawn into the interior of the body from the surrounding fine mud. In any case, the taking of these small solid bodies proceeds as in the true Amœbæ, and as in the Amœba-like blood-cells of animals, by means of the peculiar motion of the pseudopods, without a permanent opening or hollow receptacle ever being present in the solid slime-mass of the body.

Already, when, in 1863, for the first time, I observed the Protamœba, I concluded that it multiplied itself simply by division, for the individuals contained in a small glass increased remarkably in a few days, without any changes or transition to a passive condition ever having been observable in these very simple organisms. When I again found the Protamœba two years afterwards in the same pond near Jena, I tried by continued observation of single individuals to establish the nature and manner of its reproduction, and this actually succeeded. Several Protamœbæ showed in the middle of their body a more or less deep constriction, thus becoming more or less biscuit-shaped (fig. 27). The constriction continued, without affecting the changes of form which took place in each of the two halves of the body; and it became perceptibly deeper (figs. 28, 29). At last I succeeded in directly establishing the actual division of the contracted portion, and the complete separation of the two divided halves, in two individuals which I had constantly observed for a considerable time (fig. 30 A B). Each half immediately rounded itself, and then uninterruptedly continued the former slow movements. Thus was established in Protamœba the simplest form of non-sexual reproduction, *i. e.*, by division, and without being preceded by a passive state. Manifestly Monera such as *Protamœba primitiva* may be considered to occupy the first place in the hypothesis of archigony or spontaneous generation.

III.—*Remarks on the Protoplasm Theory.*

The Monera which I have just described, *Protomyxa*, *Myxastrum*, *Myxodictyum*, and *Protamœba*, as well as *Protogenes*, which I formerly described (l. c.), and *Protomonas* and *Vampyrella*, observed by Cienkowski, all perfectly agree in their whole bodies consisting when completely developed, and in their freely moving condition, of a structureless and thoroughly homogeneous substance. In all chemical and physical respects this substance shows the qualities of a consistent carbonaceous compound of the group of albuminous substances (Proteine).

It is identical with the substance which as Plasma or Protoplasm forms the contractile living substance of all organic Plastides; of all cells and Cytodes of animals, Protista, and plants. To distinguish it from the encapsuled Protoplasm enclosed in cell- or cytode-membranes, the name of sarcode, used by Dujardin, can be applied to the free Plasma without a covering to protect it from contact with the outer world. Only it must not be forgotten that the naked sarcode possesses essentially the same properties as the encysted Protoplasm, and that in the above-described Protomyxa and Myxastrum, for example, and also in the Protomonads and Vampyrellæ the sarcode must be called protoplasm as soon as these Moners encyst themselves, and enclose themselves within an outer membrane; in other words, as soon as the Gymnoplastides pass into Lepoplastides. In the indisputable fact that in the above-mentioned organisms the whole body (in its perfectly developed state!) actually consists singly and only of a jelly-like structureless Protoplasm, and that this simple homogeneous material, as the active substratum of all life-movement, without the co-operation of different parts, fulfils all essential vital functions (nutrition and reproduction, motion and irritability), I see sufficient reason to take the step of placing these organisms together as Monera in contradistinction to all others, as I have done in my 'General Morphology.' For these organisms manifestly stand in the lowest grade below all other organic beings, and not only occupy actually the simplest, but also the simplest conceivable, position of independent living matter. But as these remarkable Monera are from one point of view of the greatest interest, so from another they deserve general attention from the inestimable importance which they possess of affording a mechanical explanation of vital phenomena, and especially for a Monistic explanation of entire organic nature.

The Protoplasm or Sarcode theory, that is, that the albuminous contents of animal and vegetable cells (or more correctly, their "cell-matter"), as well as the freely moving sarcode of Rhizopoda, Myxomycetæ, Protoplastidæ, &c., are identical, and that in both cases this albuminous material is the original active substratum of all vital phenomena may perhaps be considered one of the greatest achievements of modern biology, and one of the richest in results. After this theory was brought forward in its elementary form by Cohn[1] in 1850, and by Unger[2] in 1853, it was further developed in

[1] F. Cohn, "Nachträge zur Naturgeschichte des *Protococcus pluvialis*;" 'Nova Acta Ac. Leop. Carol.,' vol. xxii, pars 2, p. 605, 1850.

[2] Unger, 'Anatomie und Physiologie der Pflanzen,' 1855, pp. 280, 282.

1858, and finally completely established in 1860, by Max Schultze.[1] I myself have laboured for a number of years to maintain and extend this theory.[2] By no phenomena is the correctness of this theory so thoroughly proved, and, at the same time, in so simple and unassailable a manner, as by the vital phenomena of the Monera, by the processes of their nourishment and reproduction, sensitiveness and motion, which entirely proceed from one and the same very simple substance, a true "primitive slime."

The protoplasm theory might now be considered as almost universally recognised if there had not arisen from one quarter for the last six years a continued energetic protest against this "heresy." As there are no very strong proofs against it to justify this opposition, we would not have alluded to it here if the influence of its opposer had not lent it an apparent importance, and if at the moment I write this a detailed treatise for the complete refutation of the "sarcode heresy" had not been published. Since 1862 Reichert, the professor of human anatomy at Berlin, who was elected in 1858 as the successor of the immortal Johannes Müller, has not only attempted, in a series of papers, to overthrow the protoplasm theory, but to prove all the previous observations on the sarcode-movements of the Rhizopoda to be so many gross errors. The currents of the protoplasm-threads are made out to be but waves of contraction of solid threads, and the granules carried along by the currents but "moving loops" of these threads. Ramifications and anastomoses of the pseudopods are never present, but have only, as "wonderful microscopic illusions, pleased the fantasy of observers," &c.

These extraordinary assertions were brought forward by Reichert with the greatest assurance after he had examined, during only a few weeks' residence at Trieste, "a not accurately identified species of Miliola and Rotalia." And as the result of these investigations he declared that all previous observers of the Rhizopoda had fallen into the grossest errors concerning their organization! Among these observers are Dujardin, Max Schultze, Huxley, Claparède, Krohn, Johan-

[1] Max Schultze, "Ueber innere Bewegungs-Erscheinungen bei Diatomeen;" 'Müller's Archiv,' 1858, p. 330. Max Schultze, "Ueber *Cornuspira*;" 'Archiv für Naturgesch, 1860, p. 287. Max Schultze, "Ueber Muskelkörperchen und das was man eine Zelle zu nennen habe;" 'Reichert und Du Bois-Reymond's Archiv,' 1861, p. 1. Max Schultze, 'Das Protoplasma der Rhizopoden und der Pflanzenzellen,' Leipsig, 1863.

[2] 'Monographie der Radiolarien,' 1862, pp. 89, 116; also "Ueber den Sarcodekörper der Rhizopoden;" in 'Zeitschr. für wissenschaftl. Zool.,' Bd. xv, 1865, p. 342, Taf. xxvi; and in 'Generelle Morphologie,' vol. i, pp. 269, 289.

nes Müller, naturalists of recognised position who had busied themselves for months, and some of them for years, with the investigation of the Rhizopoda. And all these must have been most grossly deceived "by a remarkable sport of nature!"

In my article, "Ueber den Sarcodekörper der Rhizopoden," I have clearly demonstrated the utter worthlessness of Reichert's assertions, and the perversity of his misrepresentations, and at the same time set forth the history of this strange controversy.[1] Nevertheless, Reichert has not been deterred from continuing his publications on this subject, and from metamorphosing it in a peculiar fashion in an article, "Uber die contractile Substanz."[2] By what mistakes and forced constructions this pretended vindication (but really alteration) of his former views is distinguished, has been already shown by Max Schultze in his article 'Reichert und die Gromien."[3]

A comprehensive treatise of Reichert's has just appeared, 'Uber die contractile Substanz (Sarcode, Protoplasma) und ihre Bewegungs-Erscheinungen,' which, while further developing the argument of the last-mentioned publication, is one of the most astonishing productions of modern zoological literature.[4] On reading it, we seem to have retrograded about half a century. Among other things, the existence of the epithelial cells of the Cœlenterata is contradicted; and the two epithelial forms of integument (ectoderm and entoderm) from which, according to the unanimous observations of all modern naturalists, the Cœlenterata are developed, are absolutely denied. The existence of naked membraneless cells is still persistently denied with the greatest obstinacy, although such numerous observations for so many years past have established their existence beyond dispute, so that the naked (nucleated) plasma-mass may be looked upon as the original state of nearly all cells, and the membrane always appears only as a secondary formation. Further on, the discourse is incidentally of "flint-formed creatures" (perhaps Diatomaceæ?), and so on. All these assertions do not concern us here, but only the method and manner in which Reichert treats his principal subject, and distorts the sarcode theory; this necessarily requires a decisive settlement. I will cut it as short as possible, and set forth, in the first place, the principal points in dispute.

In his above-mentioned paper, which was to "make clear

[1] 'Zeitschrift für wissensch. Zool.,' Bd. xv, 1865, p. 342.
[2] 'Monatsberichte der Berlin Akad.,' 1865, p. 491.
[3] 'Archiv für Mikrosk. Anat.,' vol. ii, 1866, p. 140.
[4] 'Abhandl. der Berlin Akad.,' 1867, pp. 151, 293.

as the light of day the errors about the sarcode," Reichert concentrated his annihilating attack, after many devious windings, in the following assertions:—(1) The pseudopods are solid contractile threads which never ramify; (2) these threads never blend together by true anastomosis, (3) therefore the threads can never be bound together by membranous dilatations; (4) the granules in the pseudopods are "loops which oscillate along the surface of the threads under the appearance of granules." Let us now compare these separate assertions with his latest exhaustive treatise, which was to establish them in every point.

(1) *The ramification of the pseudopods.*—According to Reichert's former assertions this never occurs; and the apparent ramification arises "from the dissolution and loosening of a bundle of pseudopods." Now he asserts the contrary *i.e.*, that ramification of the pseudopods really occurs, which is caused by a contractile motion!

(2) *The anastomosis of the pseudopods.*—According to Reichert's former assertions this never occurs, and the apparent union is caused by the superposition of free threads or apparent branches. Now he asserts the contrary, *i.e.*, that true anastomosis occurs in the pseudopods, since the pseudopods "themselves grow together with similar portions in a short time under the appearance of uniting!"

(3) *The flattened dilatation of the pseudopods.*—According to Reichert's former assertions this never occurs, and the apparent formation of web-like sarcode dilatations of the anastomosing pseudopods arises from "the pseudopods crossing at an acute angle and nearing each other, or, more properly, bundles of pseudopods separated into their different threads being moved from their place and squeezed together at the angle under the appearance of a layer." Now he asserts the contrary, *i.e.*, that true dilatations occur in the pseudopods, and that "the web-like expansions of the contractile substance in the sarcode-net become interposed from a portion of the contractile substance from which pseudopods are developed, maintaining its connection with the remaining portion of the contractile outer layer only by a fine pseudopod-like thread!"

(4) *The granular movements of the pseudopods.*—According to Reichert's former assertions no granules whatever exist in the sarcode, and the apparent granules are "oscillating loops of the threads!" Now he asserts the contrary, that actual granules are present besides the apparent ones, and that these last are "very small, wart-like elevations of the contractile substance."

What Max Schultze prophesied in 1866 has now actually been verified by Reichert's having made the discovery of the true granules, which have been known to all observers of the Rhizopoda for more than thirty years!

As we have seen, Reichert's latest representations are, in all essential points, the direct opposite of his former assertions. But this does not prevent him from naïvely asserting, at the commencement of his treatise, that he now brings forward the complete proofs for his purpose, and that he has thereby "thoroughly annihilated the sarcode theory which has weighed on many distinguished naturalists like a mountain for years." Indeed, one does not know at what to be most amazed in this treatise; whether at the inconceivable ignorance of a mass of the oldest discovered and most universally known facts, or at the misrepresentation and perversion of the plainest circumstances, or at the astonishing sophistry with which the case in dispute is set aside, and with which the author assumes to have finally discovered the facts which he formerly denied with the greatest obstinacy, in opposition to all other observers. Nothing is, perhaps, more remarkable in the inductive logical conclusion of Reichert than that his new observations, with which he pretends to annihilate the sarcode theory (but actually adopts it!), are founded on a single monothalamium (*Gromia oviformis*), and that he wishes to consider proved by that alone the similar structure of all the Polythalamia! It would be just as logical if Reichert asserted that all the Polythalamia possess a one-chambered (not many-chambered) shell, for Gromia (a monothalamium) manifestly possesses a one-chambered shell! We might as well, and with equal justice, assert that the placenta is absent in all placental mammals; for the marsupials have no placenta, and yet are mammals too!

It would not be worth while to devote so many lines here to Reichert's latest production if two circumstances did not demand this energetic protest.

After Reichert perceived what a mess he had got into by his first publications on the sarcode movement, &c., he tried to get out of it by giving a report of what others had long since brought forward, under new and most obscure distortions, and in expressions difficult to understand, and then vaunted it as his new discovery. He was not afraid, for instance, to quote Johannes Müller, even in one of the first sentences, as a witness for his representations (p. 151), although the observations and views of Johannes Müller on the sarcode-bodies of the Polythalamia and Radiolaria noto-

riously agree perfectly with those of all other authors since Dujardin.

The second point against which decided protest must, *in limine*, be made is Reichert's representation of the "sarcode-bodies" of the Hydromedusæ, especially of the hydroid polypes. After Reichert had suffered such lamentable shipwreck with his investigations in the direction of the Rhizopoda, he fled to the Hydromedusæ, and tried to cause similar confusion here. It sounds almost incredible that Reichert is not even in the position to understand the simplest and longest known and most easily demonstrated structures, such, for example, as the two epithelial forms of integument (ectoderm and entoderm), or the development of the urticating capsules in the epithelial cells. But this does not hinder him from declaring, even on the second page of his investigations on "Campanulariæ, Sertulariæ, and Hydroidæ," that all previous knowledge of the hydroid organism was very erroneous, and from pronouncing the following sentence by reason of his incredibly superficial examination of some hydroid polypes: "Neither the correspondence in the simple structure of the hollow body of the organism, and perhaps still less the similar external habit, and a similar formation of the individual stems, allow the classes of animals placed by Leuckart among the Cœlenterata to be retained in their present condition under such circumstances." Reichert very wisely appends the following sentence: "I must postpone the attempt to define the boundaries between which the separation of these groups of animals is apparently to be effected."

The further course of Reichert's Cœlenterata studies can be predicated from this pretty beginning, and from the analogy of his Polythalamia studies. The 'Monatsberichte' and 'Abhandlungen' of the Academy of Berlin will contain a series of papers, in which all previous observers of the Cœlenterata will be described as incompetent observers who have fallen into the grossest errors, "whose fancy has been misled by wonderful microscopic illusions." Then Reichert will show how everything is quite different to what was previously supposed, but, gradually approaching the representations just disputed by him by dark and hidden twistings and turnings, he will then finally reproduce them in the new form of his happy individual modes of expression.

As Reichert required six years for this course of comprehension in the Polythalamia, he will probably need at least twelve years in the Cœlenterata (whose true structure

is much more universally known), in order finally to bring the "errors" of other naturalists to market as his discoveries. If Reichert should live to the year 1880, for the good of science, he would then probably arrive at the present already universally known facts of the structure of the Cœlenterata. I have continually busied myself, as it happens, for the last few years, with the examination of the finer structure of the Hydromedusæ, and am therefore justified in asserting that nearly all Reichert's new statements as to the structure of the Hydroidæ are just as confused, erroneous, and worthless as his former statements as regards the structure of the Polythalamia.

One will forgive the acrimony of this controversy and excuse it, owing to the just anger which I must experience as the grateful pupil and ardent admirer of the great Johannes Müller, when I think of these extravagances of his immediate successor. The anatomical chair of the University of Berlin was raised during a quarter of a century above all others by Johannes Müller, and as Müller terminated the long series of his illustrious works with the Rhizopoda, Reichert probably thought he must begin where his great predecessor had left off, and was apparently actuated by the hope at once to surpass him! How far he has succeeded in this is manifest to all who know the literature which contains it, and have examined the objects themselves in nature.

The Protoplasm-theory, which I consider as one of the first and most important foundations of a truly monistic, *i. e.*, mechano-causal knowledge of organic nature, may be considered as newly confirmed and strengthened by this last turn in its history. The attacks of its opponent, threatening annihilation, are gradually converted by the same man into misrepresentations, and finally into confirmations. But for the true nature of the Sarcode as a truly simple and structureless "life-material," the natural history of the previously described Monera may furnish further direct proofs.

IV. *The Limits of the Protista.*

Since Charles Darwin revived the theory of descent originated by Jean Lamarck and Wolfgang Goethe from the oblivion of half a century to fresh life, and placed it by his theory of natural selection on an unassailable causal-mechanic foundation, the problem of systematic arrangement has become a very different and immeasurably higher one. Hitherto, this was a scientific game in the hands

of most zoologists and botanists, which amused itself with the affinities in form of similar natural bodies, without suspecting their real blood-relationship thus indicated. The chief employment of most systematising naturalists consisted of endless and utterly useless controversies on the question as to whether this or that animal or vegetable form was a "good" or a "bad species," a subspecies or variety, a subgenus or genus, without its occurring to these over-precise savans to explain to themselves previously the limits and object of these ideas. But now, on the other hand, when the untenability of these as absolute ideas, and their proper importance as relative ideas, are recognised, when the "acting cause" of variation of form is discovered in "blood-relationship," the by far higher, more difficult and more interesting problem encounters us, that of fixing by the discovery of the "natural system" the pedigree and the relations of descent of allied groups hypothetically the nearest related.

This task nowhere encounters more difficulty than in the lowest and meanest organisms. It is comparatively easy to fix the pedigree of vertebrate animals with approximate certainty, when compared with the extraordinary difficulties which encounter us in the pedigree of the so-called Protozoa. While everywhere there definite highly and many-sided differentiated systems of organs present firm hold-points, here there are no such systems of organs present. While a number of classes and orders have long been there recognised as truly natural groups, here this can be maintained of but few groups. *There* is a consistent and rich material collected by the experience of centuries; *here* loose collections of isolated facts have become known for barely two decades. No wonder therefore if the most horrible confusion prevails in the arrangement of these very low organisms, and everybody makes a system for himself.

I have made the attempt in my 'General Morphology' to throw some light upon this systematic chaos, by placing, as a special division between true animals and true plants, all those doubtful organisms of the lowest rank which display no decided affinities nearer to one side than to the other, or which possess animal and vegetable characters united and mixed in such a manner that, since their discovery, an interminable controversy about their position in the animal or in the vegetable kingdom has continued. Manifestly this controversy becomes reduced to the smallest compass if the disputable and doubtful intermediate forms are separated for the present (although only provisionally) both from the true animals and from the true plants, and united in a special

organic "kingdom." Thereby we obtain the advantage of being able to distinguish both true animals and true plants by a clear and sharp definition, and, on the other hand, a special proportion of attention is attracted to the very low organisms hitherto so much neglected, and yet so extremely important. I have called this boundary kingdom intermediate between the animal and vegetable kingdoms, and connecting both, the Protista ('Gen. Morphol.,' vol. I, p. 203; vol II, p. xx, p. 403).

I have, of course, by this separation of the Protista from plants on the one side, and from animals on the other, by no means wished to establish an absolute and lasting wall of separation between these three organic kingdoms. Rather, I consider it very probable that animals as well as plants have derived their origin from the Protista, and in fact from the simplest Protista, the Monera (l. c. vol. II, p. xx, p. 403, pl. 1). But provisionally I consider it convenient on practical grounds to separate the Protista in the system of nature entirely from animals as well as from plants.

In the systematic introduction to my 'Universal Development-history,' I have distinguished the following eight natural groups or "stocks" (Phyla) of the Protista.

I. Monera.

1. Gymnomonera (Protogenes, Protamœba, &c.).
2. Lepomonera (Protomonas, Vampyrella, &c.).

II. Protoplasta.

1. Gymnamœbæ (Autamœba, Petalopus, Nuclearia, &c.).
2. Lepamœbæ (Arcella, Difflugia, Euglypha, &c.)
3. Gregarinæ (Monocystidea and Polycystidea).

III. Diatomaceæ.

IV. Flagellata.

1. Nudiflagelata (Euglena, Spondylomorum, &c.).
2. Cilioflagellata (Peridinium, Ceratium, &c.).

V. Myxomycetes.

VI. Noctilucæ.

VII. Rhizopoda.

1. Acyttaria (Monothalamia and Polythalamia).
2. Heliozoa (*Actinosphærium Eichhornii*).
3. Radiolaria (Monocyttaria and Polycyttaria).

VIII. Spongiæ.

1. Autospongiæ.
2. Petrospongiæ.

Since the separation of these eight groups of Protista, a new group of organisms of the lowest class has become known, which cannot be placed in any of these eight divisions without violence, and which, like the latter, exhibits such a combination of animal and vegetable characters, that they can just as little be recognised as true plants as true animals. These are the remarkable Labyrinthulea (*Labyrinthula vitellina, L. macrocystis*) which were discovered in the harbour of Odessa[1] by Cienkowski, to whom the natural history of the Protista is so much indebted. At all events, these must be provisionally considered as an entirely separate group of Protista.

(To be continued.)

On Raphides, Sphæraphides, *and* Crystal Prisms; *especially as to how and where they may be easiest found and discriminated. By* George Gulliver, F.R.S.

What are the distinctive characters of raphides, sphæraphides, and crystal prisms? How may they be surest and easiest found, and in what common plants? Is not the occurrence of raphides very inconstant, seeing that either their presence or absence in one and the same plant is alternately affirmed and denied, and that they are not always found in those very species or classes, such as the "tulip-bulb" and "monocyteledons generally," in which we are directed to look for them?

Such questions as these so often arise that the answers now proposed thereto, with a few incidental observations on the significance or use of plant-crystals, may prove convenient and useful to the readers of the 'Quarterly Journal of Micro-

[1] 'Archiv für Mikrosk. Anat.,' vol. iii, 1867, p. 274, Taf. xv—xvii.

scopical Science.' And this the more so, as it is quite true that vague statements and perplexing errors concerning raphides are too prevalent even in our best and latest books on the microscope; while the importance of these crystals as truly constant and natural characters in systematic botany has neither been realised nor recognised in our floras.

Indeed, the whole question of the value of our plant-cells as diagnostic characters of nearly allied orders and species has been so strangely neglected that attention has been again very judiciously directed to it by the editors of this Journal. [1] have only detached and fragmentary materials

ERRATA IN MR. GULLIVER'S MEMOIR.

Page 233, line 8, *for* our plant-cells, *read* plant-cells.
" 233, " 41, *for* nearly chemical, *read* merely chemical.
" 234, " 6, *for* these transverse slices, *read* thin transverse slices.
" 234, " 12, *for* our own fields, *read* our fields.
" 235, " 36, *for* 'Ann. Nat. Hist.,' 1866, *read* 'Ann. Nat. Hist.,' 1863.
" 235, " 38, *for* deep fragments, *read* dead fragments.
Passim, *for* Briony, *read* Bryony.
Page 237, line 5, *for* Our Endogens are more affluent than our *Endogens* in raphides, *read* Our Endogens are more affluent than our Exogens in raphides.
" 237, " 7, *for* Grape, Hyacinth, &c., *read* Grape-hyacinth.
" 239, " 16, *for* tubular crystals, *read* tabular crystals.
Passim, *for* Allieæ, *read* Allieæ.
Page 240, line 4, *for* Sponges, *read* Spurges.

To Binder.—*Insert between pages* 232 *and* 233.

as remarkable for their beauty as for the facility and certainly with which they may be found and distinguished, displayed, and preserved. To find them nothing more is required than to

[1] 'Quart. Journ. Micros. Science,' Oct. 1863, and Jan., 1866.

examine, under an achromatic object-glass of half an inch focal length, fine longitudinal sections of the plant-tissue, or fragments of it mashed by the point of a penknife in a drop of water, on the object-plate. Deeper magnifying powers, of course, will be needful for further research. Sphæraphides are often best seen in these transverse slices of the stem and leaves; and the sphæraphid tissue in delicate films either cut or torn off lengthwise.

And now we may proceed to explanations in due order of the remaining questions, and for this purpose suitable examples will be selected from the most familiar plants of our own fields and gardens, and from common officinal things. More extensive and particular details may be found, especially as regards measurements, composition, etymologies, and the distribution of raphides in the Flora of Britain and of the world, in my papers published elsewhere.[1]

1. Raphides.—These are slender needle-like crystals, with rounded, smooth shafts, vanishing at each end to a point, from about ten to fifty or more lying parallel together so as to form a bundle which partially fills a cell or intercellular space. When undisturbed, this bundle lies along its cell, but the raphides are often so easily displaced by slight pressure on the object-plate, that either all or part of them cross the cell in various directions, sometimes gravitating to one of its ends, and occasionally escaping quickly from one or both of them. In this last case they have been described as "biforines" by the continental writers. Thus, though the raphides lie close together in each bundle, their connection with each other is really as loose as that between a packet of sewing-needles, and, accordingly, when these crystals are first shown to a novice, their likeness to a lot of needles is sure to be noticed. The raphis-cell is commonly very distinct, often oval and tumid; it contains a lot of viscid or

[1] "On Raphides," &c., various numbers of 'Annals of Natural History,' 1861-1865; 'Seemann's Journal of Botany,' March, 1864; 'Quart. Journal Micros. Science,' January, 1864; "Raphides as Natural Characters," in the 'British Flora,' *ibid.*, January, 1866; and in the "Flora of the World, with Epitome of my former Observations," 'Popular Science Review,' October, 1865; "Cells and Raphides of Duckweeds and Exraphidian Character of Wolffia," with figures, 'Seemann's Journ. Bot.,' Dec., 1866, and January, 1869; "Pith-Cells of Rushes," 'Ann. Nat. Hist.,' plate vii, figs. 13 and 14, December, 1863; "Vegetable Fibrin and Latex," *ibid.*, March, 1862; "Tissue-Cells and Spores of Hymenophylleæ," with figures, *ibid.*, August and October, 1863, and 'Seemann's Journ. Bot.,' October, 1863; "Pollen-Grains," 'Annals Nat. Hist.,' July, 1865; "Seemann's Journ. Bot.,' with figures, September, 1866; 'Popular Science Review,' July, 1868.

semifluid and pale protoplasm, in the midst of which lies the bundle of raphides; the cell is frequently much elongated, and occasionally pointed at both ends, and regularly, but not always, differs in its shape and larger size from the neighbouring tissue-cells. Sometimes, especially in old parts of the plant, though the bundle of raphides is plainly seen in a space thus distinct, it is difficult or impossible to demonstrate the existence of a proper cell-wall or other boundary than that which is formed by the outsides of a a number of the contiguous tissue-cells, and occasionally,[1] as may be seen, in the pulp of ripe fruits and other such parts, the crystals occurred without any apparent cell or boundary whatever.

Thus, restricting the term raphides, there will be no likelihood of applying it incorrectly. The greatest confusion has long since prevailed, and still prevails, from the loose application of this term to several different forms of plant-crystals. And with this understanding, let us proceed to notices of such raphis-bearing plants as are everywhere common.

Raphides among our native Exogens are confined, as far as is at present known, to the three orders—Galiaceæ, Balsaminaceæ, and Onagraceæ. The raphides are small in Galiaceæ, larger and well seen in Onagraceæ, both British and foreign; and as the Willow Herbs are plentiful in every ditch or road-side, and numbers of exotic species of this order are grown in the humblest gardens, while Balsams are familiar pets both in the cottage and greenhouse, some part or other of plants of these two orders are ever at hand for examination. The Evening Primrose answers the purpose very well; so do Clarkia, Eucharidium, Godetia, and that pretty native species, the Enchanter's Nightshade. The Fuchsias are great raphis-bearers, and good subjects for the examination of the raphides in the berry-pulp and in the ovule-coat and placenta, as figured by me on page 366 of the 'Annals of Natural History' for November, 1866. Of the Onagraceæ, even, the seed-leaves during the genial season, and deep fragments of the stems and leaves, as well as parts still alive underground, in winter, may be easily known by their raphides from plants of other and closely allied orders.

So, too, may the Marvel of Peru and the Mesembryanthemums, in which raphides are very plentiful, and by which character simply Mesembryanthemums may be also clearly distinguished from other thick-leaved plants. Indeed, I have long been in the habit of thus distinguishing Cras-

suleæ from Mesembryaceæ—and here, too, this diagnosis holds good, from the very cradle to the grave of the species. Experiments to this end may be easily repeated on old or dead plants and on seedlings of the many Mesembryanthemums and Sedums grown in pots; and when together in the same pot, the evidence will be quite conclusive that the raphides are produced in one of the two plants, and not in the other, though both are under the very same conditions of soil and climate; in fact, all my experiments and observations are to the effect that no raphis-bearing species can grow and flourish without producing raphides, while the raphidian organism cannot be formed under any circumstances in other plants.

Of our Exogenous trees and shrubs, I know not a single raphis-bearer, though other crystals are common in their plants generally, and raphides are found in many exotic trees and shrubs of this class; facts thus far noteworthy and deserving of further inquiry. Boih raphides and sphæraphides are plentiful in Vitaceæ, of which either the Grape Vine or American Creeper may be had at any time for examination, though the leaves, young shoots, ovaries, and ripe fruit are in some respects best for the purpose.

Our Dictyogens abound in raphides, as may be well seen in the Black Briony and Herb Paris; and so does the Trillium of the gardens. Of Tamus the raphides appear loose and destitute of a cell in the ripe berry-pulp, and in the root-stock; this root is like a little Yam, and the officinal Yams, so commonly used as food in the West Indies, and the New Chinese Yam (*Dioscorea Batatas*), of late years vainly advertised and cultivated as a substitute for the potato in England, are both also Dictyogens affording raphides. At Covent Garden different things are exposed for sale, as Yams, one of which belongs to the exraphidian order Convolvulaceæ. In Paris quadrifolia the raphis-cells are elongated, pointed at the ends, and much larger than the contained raphides, as may be well seen through the tissues of the perianth-segments. Both this and Tamus are good plants for these examinations; and in some districts, as the clayey parts of Kent, the scarlet berries of the Black Briony adorn the hedges during the autumnal and winter months. A botanical friend was so much disappointed at not finding raphides in "some scarlet berries of Briony" that he produced the fruit for my correction; but it soon appeared that he had only got the Red Briony, a plant of the Exogenous order Cucurbitaceæ, and which I have always described as exraphidian. He might as well have searched for raphides in

hips and haws. The Sarsaparilla of the shops affords raphides; but not so the North American or false Sarsaparilla, which is one of the Araliaceæ abounding in sphæraphides, but devoid of raphides.

Our Endogens are far more affluent than our Endogens in raphides. They are plentiful throughout the Blue Bell, Grape, Hyacinth, and Star of Bethlehem, and may be well seen in the ovule-coat of this last plant. Beautiful, too, they are, with their large, pale, soft cells, in the Cookoo-pint and other Araceæ, and especially in the berries of these plants, as shown by Fig. 3, p. 366, of the 'Annals of Natural History' for November, 1863. Under slight pressure the bundle of raphides breaks up, so that they lie in different directions within the cell, often gravitating towards one end, sometimes escaping thence, and occasionally in a very remarkable manner from both ends. These "biforines" are well seen in Colocasia; Richardia and Caladium are also common greenhouse plants of the order full of raphides. Of the Duckweeds, *Lemna minor* and *L. trisulca* abound in raphides, while they are comparatively scanty in *L. polyrrhiza* and *L. gibba*, and are totally wanting in Wolffia, as shown in my figures of the cells of Lemna and Wolffia, in 'Seemann's Journal of Botany' for December, 1866, and January, 1869, where, too, the bundle of raphides of a mature leaf of *L. trisulca* appears destitute of a proper cell-wall, the boundary of the space being formed merely by the outer wall of the contiguous tissue-cells. In *Pistia Stratiotes*, or tropical Duckweed, both raphides and sphæraphides occur; and this plant may be had of Mr. Kennedy, at Covent Garden. The English Orchidaceæ abound in raphides, and it is remarkable that the illustrious Robert Brown, who only noticed them in this order, gave such a true description of the shape of these crystals as distinguished them clearly from crystal prisms. Of the Lady's Tresses the raphides are easily seen through the semi-transparent bract-like stem-leaves; and the cells containing the much smaller bundles of raphides are pretty objects both in this plant and in the Marsh Helloborine. Raphides occur in the Lily of the Valley; in Asparagus they are abundant from its root to its berry and ovule; and in the bulb-scales, leaves, and scape of the Daffodil. Other Amaryllids, as the Narcissus, abound in raphides; and in the officinal Squill they are very large and plentiful.

II. Sphæraphides are more or less rounded forms, made up of a congeries of crystals, many of which are prisms, often acicular. The sphæraphides are more or less rough on the

surface, or even stellate, from projections there of the crystalline angles or tips of the prisms; and frequently occur, very regularly disposed, in a perfect network of cells, which I call Sphæraphid Tissue, and a pretty one it is, engraved in the 'Annals of Natural History' for September, 1863, plate iv, fig. 13. Sometimes each of the sphæraphides seems to be connected by a slender pedicle to the inside of the cell-wall, and then noticed by Continental writers as a 'cystolith.' Meyen, I think, originally described this organism in Ficus; the presence in many other allied plants of such crystals was observed by Payen; Weddell called them 'cystoliths,' and insisted on their value as a diagnostic character. Great are the merits of the brothers Quekett, who distinguished sphæraphides under the name of 'conglomerate' raphides, and added greatly to our knowledge of this branch of Phytotomy. They are generally by other writers confounded with and simply designated as 'raphides.'

Sphæraphides are very common and widely diffused in Phanerogamia, as may be easily witnessed among our Caryophyllaceæ, Geraniaceæ, Lythraceæ, Haloragaceæ, Chenopodiaceæ, Urticaceæ, and a host of other British plants. The leaves or stem of the Hop, Nettle, Pellitory of the Wall, and many Goosefoot-weeds, are good plants for sphæraphides; and the cystoliths may be successfully examined with the aid of an objective of an eighth of an inch focal length in these first three species. The leaves of the Mulberry will also answer this purpose; and the sphæraphides are pretty in the fruit-capsule of the Elm, as well as in many parts of the Sandworts, Spurrey, and Saxifrages. The sepals of the Loosestrife and Geraniums, and many other common and native plants, afford good examples of the sphæraphid tissue; but it is far more remarkable in the inner layers of the bark of *Aralia spinosa*, a North American shrub, long and well known on our lawns.

And indeed sphæraphides are much larger, forming even a weighty grit, in many exotic species, as is notorious in Cactaceæ. Magnificent sphæraphides are those of the 'Prickly Pear,' often for sale at the fruiterers; and they are well seen, though smaller, in the petioles of the Passion Flowers, throughout the potherb called New Zealand Spinach, and in the North American or false Sarsaparilla (*Aralia nudicaulis*) of the shops.

III. Crystal Prisms are acicular forms with well-marked faces and angles both on the shafts and tips. These prisms neither occur in bundles, nor loosely in a cell or other space,

but are closely imbedded in the plant-tissue, either singly or two or three together; in the last case often united side by side, as if by partial fusion of their shafts, and seldom easily separable from each other. They are commonly much larger, and occasionally smaller, than raphides; but, however small the crystal prisms may be, they are easily distinguishable by the characters above specified from raphides, and yet these two different kinds of crystals, as well as sphæraphides, are still commonly confounded together under this lastname, and perpetual mistakes and perplexities occur accordingly.

Among our Exogens good examples of crystal prisms must be rare. They are small, but distinct when highly magnified, in the ovary-coat of many Compositæ, as the Thistles, Saw-wort, and Knapweed, and somewhat larger in the Milk-Thistle. These little prisms must not be confounded with the still smaller, but square, cuboid, tubular, lozenge-like, and other forms, common in these plants, and, indeed, throughout some of the tissues of the whole Phanerogamia. Certain closely allied plants may be easily and surely distinguished by one or other of them and the crystal prisms. Thus, while the shape of the prisms in the ovary-coat of *Centaurea nigra* is very distinct, and their length $\frac{1}{1000}$th of an inch, with a thickness of $\frac{1}{4400}$th, in the same part of *C. ragusina* and *C. Scabiosa* they are not thus elongated, but appear more or less square, cubical, or lozenge-shaped, and about $\frac{1}{4400}$th of an inch in diameter. But magnificent crystal prisms are afforded by many exotic Exogens, of which excellent examples occur in the common officinal barks of Quillaja and Guaiacum.

Such, too, are frequent in Endogens, as the old garden favourite *Iris Germanica*, and many other Iridaceæ, including the Orris Root of the shops. In Fourcroya, an Amaryllid, the crystal prisms are still more remarkable. They sometimes appear with raphides in one and the same plant, as may be witnessed in other Amaryllids, as well as in certain Orchids and more orders. All the large crystal prisms are admirably adapted for experiments with polarized light. The bulb-scales of the Onion, Shallot, Garlick, and Leek, abound in smaller prisms, many crossing each other, and also affording pretty objects for the polariscope; but I have never seen true raphides in the Allicæ.

IV. Conflicting Statements.—Remarkable is the potency of error. Here it has arisen and prevailed partly from insufficient observations, but chiefly, as before noticed, from the general practice of confounding several distinct kinds of

plant-crystals under the single term of raphides. Very likely those so early mentioned by Rafn in Euphorbiaceæ were only the starch-rods which I have described in the latex of the British Sponges ('Ann. Nat. Hist.,' March, 1862). Other observers, truly finding either crystal prisms or raphides in many bulb-scales, by some mistake mentioned the Tulip; whereas, though either crystal prisms or raphides occur in the bulbs or their scales of numerous common Endogens, these crystals are not regularly present in any part of the Tulip, nor are the Allicæ raphis-bearing plants, though we have seen how plentiful in the bulb-scales of this family are crystal prisms. And as to such statements, in books on the microscope, that "Monocotyledons generally" abound in raphides, and that "there are few of the higher plants in which they are not found," it is obvious that many different kinds of crystals must have been, as they too often still are, confounded under the one term, and that the observations are otherwise vague or loosely recorded. Though, as we have seen, raphides are abundant in our Monocotyledons, there are immense sections of this class nearly or quite devoid of them, and by no means rich in other crystals. Had the observers duly distinguished the different forms of crystals, and instead of examining the very common raphis-bearing Monocotyledons, confined their attention to the Grasses, Sedges, Rushes, Pondweeds, Water Plantains, Hydrocharids, and Water Starworts, the regular deficiency of raphides in such a great proportion of the class would have been duly discovered and recorded. I have for years vainly searched these abundant and familiar plants for raphides, which are always present in other equally common species, growing in the very same places; in short, always proving such facts as raphis-bearing Duckweed and exraphidian Water Starwort close together in the pool, raphis-bearing Orchids and exraphidian Grasses with their roots intermingled in the field.

V. Use of Plant-Crystals.—Although the precise use of these crystals in the vegetable economy may be obscure, it is plain that whatever is constant in the plant must be important, and by no means necessarily of little importance because of such obscurity. Poor Charlotte Smith, who loved plants so well and truly, sung of them—

> "All are for use, for health, for pleasure given,
> All speak in various ways the bounteous hand of heaven."

And when we consider how commonly plant-crystals are

composed of phosphate or oxalate of lime, or some other compound of this earth, its value in the growth or nutrition of animals and vegetables, and that nature has established in certain plants a laboratory or storehouse of such calcareous salts, we get a glimpse of the utility of these crystals. They are plentiful in many parts which form the food of birds and mammalia, and medicine or food for man, and of which exact examples might be given in Thistle-seed and Duckweed, and numerous other plants. The well-known efficacy of Sarsaparilla in certain cachexies is probably in great part due to the phosphate of lime composing the raphides so plentiful in this medicine, by which the quality of the officinal samples of it may be tested, and its value as a remedy in the Rickets of children suggested ('Ann. Nat Hist.,' June, 1864, p. 510). In like manner the crystal prisms of Guaiacum and Quillai and the raphides of Squill are noteworthy tests of the genuineness of those drugs, while we have already proved the use of raphides as diagnostics in systematic botany. Nor will any one who may pursue the inquiry fail to admire and take pleasure in the objects. And when, by the periodic shedding of the leaves, the surplus crystals are restored, it is to fertilise the bounteous earth; and withal, good reason appears why the gardener husbands decayed leaves for his composts, and why such plants as abound most in raphides, as do the Willow Herbs, Fuchsias, and Duckweeds, should be especially valuable in this respect.

And now it is hoped that a sufficiently clear account has been given of Raphides, Sphæraphides, and Crystal Prisms, to enable even the merest novice easily and surely to find and discriminate these different plant-crystals, and at any season, either in town or country, while there can be no doubt that such observations would afford an elegant and instructive addition to rural amusements. Thus, too, without application to dealers, the number of interesting and beautiful microscopic objects might be largely and very readily increased; and the inquiry, if carefully and diligently pursued to its legitimate conclusion, could hardly fail to extend the bounds of botanical science.

Immersion Objectives *and* Test-objects. By John Mayall, Jun., F.R.M.S., &c.

(Read before the Royal Microscopical Society, October 14, 1868.)

The presentation of Dr. Woodward's photographs[1] of Nobert's Nineteen-band Test-plate, brought to the notice of the Society by the Hon. Secretary, Mr. Jabez Hogg, affords an opportunity of making a few remarks on their value as a record of what has been done in America in resolving these marvellously fine lines; and as in my experiments I found some difference in the results obtained on Nobert's plate by the immersion and the dry objectives, I think it will interest the Society to be informed of these results, because the relative separating and defining power of the two systems has not received that attention which I and many others think it deserves.

The only way we have of verifying the accuracy of the divisions of Nobert's Test-lines is by counting them in a measured space. For example: if 46 equidistant lines are ruled in the space of $\frac{1}{1000}$th of an inch, the interspace must be at the rate of 90,000 to the inch, and so on. An error of one line more or less in counting the whole of the lines on such a band would decide the rate of the interspaces to be either 92,000 or 88,000, instead of 90,000 to the inch.

Dr. Woodward's photographs support an opinion given by Mr. Wenham many years ago, that the time would come when photography would reveal minute detail much more palpably than it can be seen in the microscope. The reason of this is obvious. In photography the object may be illuminated by highly condensed sun-light—a light producing the intensest black shadows, and quite unendurable to the eye—and it was with such illumination that these photographs were obtained. They may be accepted as showing true lines on all the bands to the fifteenth inclusive; but beyond this, they serve little purpose of verification. Repeated trials on the higher bands, as shown in the photographs, have convinced me that Dr. Woodward's counting includes or rejects such doubtful lines, that it cannot be accepted as exact evidence of the number of lines ruled on the plate. I think, too, that he underrates the difficulty of counting the lines. In all the bands beyond

[1] See Dr. Woodward's paper in the 'Journal,' October, 1868.—Ed.

the twelfth, as I have seen them in the microscope, there is great difficulty to decide on the first and last lines. Dr. Woodward seems not to have been sure of the accuracy of the count he made on his photograph; for although in one part of his paper in the current (October) number of the Journal of this Society, he says the photograph shows the twelfth band as resolved into *thirty-seven* lines, farther on he says that *forty* is the real number in that band.

It cannot be supposed that all the corresponding bands on different plates agree precisely in difficulty to resolve; it follows that a comparison of results obtained by two objectives, each tried on a different plate, may be very deceptive; though when tried on the same plate their relative separating power is at once decided.

It was only after frequent trials that I could be assured of distinguishing readily between the appearance of the true consecutive lines and those woolly or wavy-looking lines, which are shown either by defective illumination or by the want of power in the objective, but which are sometimes believed to be imperfectly ruled lines.

With the $\frac{1}{8}$th and the $\frac{1}{12}$th by Ross, and the $\frac{1}{20}$th by Smith, in the possession of this Society, and with a $\frac{1}{8}$th, a $\frac{1}{12}$th, a $\frac{1}{16}$th, and a $\frac{1}{25}$th by Powell and Lealand, all dry objectives (not to mention others which gave similar or inferior results), on a new nineteen-band plate, all the bands beyond the twelfth seemed imperfect—the lines were not separated.

But with a $\frac{1}{16}$th and a $\frac{1}{18}$th by Hartnack, of Paris, a $\frac{1}{16}$th by Merz, of Munich, and a $\frac{1}{20}$th of Nobert, all immersion objectives, straight and well-defined lines were separated as far as the fifteenth band inclusive. In the last four bands true consecutive lines were seen; but they are so extremely slightly ruled, that the eye fails to appreciate their increased fineness. I should expect that, if the lines in the twelfth band were as slightly ruled as those on the last four bands, there would be nearly the same difficulty in seeing them, notwithstanding their wider separation. If the lines were exposed to the incident light, without the interposition of any reflecting surface or refracting medium, they would, doubtless, be seen with much greater ease.

These results were the best I obtained by the dry and immersion objectives with the same method of artificial illumination. Several trials with sunlight proved that the lines were thus rendered more visible; but the immersion objectives maintained their superiority by all methods.

I can find no evidence whatever for the statement that the resolving of Test-diatoms and Nobert's Test-lines is

merely a question of *angular aperture*. Ross's $\frac{1}{12}$th, Smith's $\frac{1}{20}$th, Powell and Lealand's $\frac{1}{12}$th, and $\frac{1}{16}$th dry objectives were all of larger aperture than Merz's $\frac{1}{16}$th Immersion, yet neither gave as good results on *Surirella gemma*, *Frustulia Saxonica*, *Grammataphora Subtilissima*, *P. Angulatum*, *P. Attenuatum*, *P. Macrum*, &c., nor on Nobert's plate, as Merz's objective. Hartnack asks the question, "Are large apertures an advantage to the microscopist or to the optician?" and he frankly says that "the disadvantages are for the latter only."

The advantages mainly claimed for the Immersion objectives are:—greater working distance between the object aud objective, increase of light and superior definition and clearness in the optical image, which image is obtained by much simpler illuminating apparatus and with less manipulative skill than that considered indispensable in using high-power dry objectives.

It is not difficult to see that Amici's system, of connecting the objective with the cover-glass by a film of water, very much diminishes the reflexion which necessarily takes place on the incidence of oblique light when the dry objective is employed. The limiting angle of refraction in water being about forty-eight degrees, it follows that, whatever is the degree of obliquity in the incident light on the object, the Immersion objective never has to do with rays of greater obliquity than forty-eight degrees. To this, in great measure, is due the greater clearness and precision of image obtained.

Continental opticians and men of science have been aware of the merits of the Immersion system during several years past; and to such purpose, that knowing how little attention it has received here, they do not scruple to say that the English no longer take the lead either as opticians or as microscopists.

There are amateurs who make a speciality of declaring that all Test-objects can be resolved by some wonderful $\frac{1}{4}$th objective. I am told, for instance, that coarse transverse and very fine straight longitudinal lines can easily be seen with a $\frac{1}{4}$th on *Surirella gemma*. It is well known that a low power will show transverse lines; but no objective or method that I know of shows straight longitudinal lines on this diatom. The finest images that I have seen of *Surirella gemma* (with Hartnack's $\frac{1}{18}$th and Nobert's $\frac{1}{20}$th), do not confirm Hartnack's opinion that the surface is a series of elongated hexagons, similar to the drawing in his pamphlet on "Test-objects" (published in 1865, and copied by Dr. Carpenter in the last edition of his work on "The

Microscope"), but show it to be analogous to that of the *Grammatophora subtilissima*. *Surirella gemma* may truly be called a *touchstone* for a high-power objective. I do not think that it has been clearly defined as yet.

Those who profess that so much can be done with $\frac{1}{4}$th objectives in resolving Test-objects must not expect higher powers to verify the results they obtain. The whole art of testing objectives, I imagine, is in being sufficiently critical as to what is a fine image. The image shown of Test-objects by a high power of fine definition is so much more elaborated as at once to prove that the lower powers do not give true definition beyond a moderate magnification. For example, a good $\frac{1}{4}$th by Dallmeyer shows transverse lines on the *Grammatophora subtilissima*; whereas, with equal magnification, but with power in the objective (as in Hartnack's $\frac{1}{10}$th) rather than in the eye-piece, these transverse lines are seen to be the result of imperfect definition, and the surface appears similar to the *Grammatophora marina*, or *P. angulatum*; it is, however, much more difficult to resolve.

It has been said that objectives which give the best results on Nobert's Test-lines and on Test-diatoms necessarily give inferior images of Podura scale. It is quite certain that the more powerful objectives—those giving greater magnification and definition—do not give so flattering an image of Podura scale as is given by a good $\frac{1}{4}$th. But the fault, if anywhere, is in the object, not in the objective. Podura scale is as fine a test as any for a $\frac{1}{8}$th, but not for the higher powers.

In conclusion, I would suggest that the Society should improve the collection of Test-objects in its possession, and specially that we should have one of Nobert's new Test-plates, so that the Fellows may try their objectives on a standard test of this kind.

On the Identity *of the* White Corpuscles *of the* Blood *with the* Salivary, Pus, and Mucous Corpuscles. By Joseph G. Richardson, M.D., Formerly Resident Physician at the Pennsylvania Hospital.

The nature of the nucleated corpuscles so abundant in the saliva has long been a subject of some uncertainty, and although they have probably, as favorite test objects for the higher powers, been more frequently examined by microscopists than almost any other constituent of the glandular secretions, observers seem to have been generally contented

to accept them simply as useful measures for the capacity of the higher objectives, and passed on without any attempts to solve the mystery of their origin; Kölliker, indeed, advanced the theory that they were essentially a form of exudation-corpuscles, but hitherto his hypothesis does not appear to have been generally accepted by microscopists as a fixed fact.

The following experiments, undertaken to elucidate their constitution, were performed with the large Powell and Lealand's instrument, so long a denizen of the "Microscope Room" in the Pennsylvania Hospital, and no doubt endeared by constant association to many generations of "Residents," as well as to myself. When it was discarded by the institution I became the purchaser, and after undergoing some repairs, and having adapted to it a $\frac{1}{25}$th-inch objective (made by Mr. William Wales, of Fort Lee, N. J.), it has accomplished the work below described.

The salivary corpuscles examined under a power of eleven hundred diameters present the appearance of perfect spheres, varying from the $\frac{1}{1400}$th to the $\frac{1}{2500}$th of an inch in diameter, each having a very transparent but beautifully defined cell-wall of exceeding tenuity, which incloses from one to four almost equally transparent nuclei of a circular or oval form, whose diameters range from $\frac{1}{3000}$th to $\frac{1}{4000}$th of an inch. These nuclei are situated sometimes centrally, but more commonly near one side of the corpuscle, and the cavity between the margin and the cell-wall is generally filled with from 25 to 50 molecules, not more than $\frac{1}{20000}$th of an inch in diameter, whose characteristic is that of constant and rapid motion. Some of these molecules seem to be elongated into an oval or hour-glass form, but the activity of their movements renders it difficult to ascertain this with precision. In my observations these corpuscles have appeared to enlarge and become flattened, from the pressure of the glass cover, as the stratum of liquid beneath became thinner from marginal desiccation, so that usually in the course of an hour or so they burst, and discharge about one fourth of their contents, when two, three, or more of the molecules swim away, continuing their revolving movements until they pass out of view; the other granules outside and those remaining within the cell become within a very few seconds entirely stationary. If a solution of aniline red, of the strength of one grain to the ounce of distilled water, be allowed to penetrate at the margin of the cover, the nuclei of the salivary corpuscle are readily stained of a bright crimson, and are thus exhibited with beautiful distinctness; the dye appears, however, to exert an immediate influence

upon the movement of the molecules, as I have rarely been able to find cells in which they continued to move after the nuclei became at all coloured.

In examining some urine, obtained on the 8th of August, 1868, near my late residence, in Western New York, from a patient who complained of severe pain in the kidneys and bladder, I was surprised to find that a deposit, which appeared to the naked eye purulent, was chiefly composed of cells, exactly resembling in form, size, definite cell-wall, contained nuclei, and actively revolving molecules, the salivary corpuscles with which I had become so familiar; and should have imagined that these proceeded from an accidental adulteration with sputum, had I not been fortunate enough to have ocular demonstration to the contrary when procuring the specimen. I examined these corpuscles repeatedly in the course of the two following days, during which the movements of the molecules continued, but could make nothing else of them except drawings, which I carefully preserved.

On consulting the text-books to which I had access, I found that neither Beale, Roberts, Bird, nor Naubauer and Vogel, in their works on the urine, mentioned cells such as those above described, although the editors of the 'Micrographic Dictionary,' in their description of the salivary corpuscles, state that they have seen them by myriads in the renal secretion; nevertheless, numerous specimens examined during the following few months, seldom without special scrutiny for similar bodies, afforded none, until in a deposit occurring from urine brought me by a medical friend about December 1st, the corpuscles I had so long been in search of were at last recognised, and on this occasion I was able to exhibit them to several microscopists, among others to my friend, Dr. H. C. Wood, Jr., Prof. of Botany, in the University of Pennsylvania.

On the 5th of December I procured a sample of urine from a case of cystitis, which had only been passed a few hours, and on placing it under the field of the $\frac{1}{4\,5}$th, I found many of the pus-globules exhibiting the amœbaform movements described by Dr. Beale in his late elaborate work on the "Microscope in Practical Medicine;" no corpuscles containing moving molecules were visible, but observing that some of the pus-cells having a spherical outline were almost opaque and only about $\frac{1}{3\,0\,0\,0}$th of an inch in diameter, it occurred to me that they were perhaps only contracted by the exosmose of their fluid contents into the surrounding denser medium, and the idea suggested itself to try the effect of diminishing the specific gravity of the urine by the

addition of water. Under this treatment I found that the cells which had been exhibiting amœbaform movements, soon assumed a spherical shape, rapidly enlarged until they reached the diameter of about $\frac{1}{1700}$th of an inch, when the contained molecules began to revolve, and ere long took upon themselves the extremely rapid and confused movements which I had twice before seen in cells occurring in urine, and hundreds of times in the salivary corpuscles; the action of aniline solution rendered beautifully distinct, definite nuclei similar to those found in the salivary bodies.

The opportunity of corroborating the interesting and remarkable researches of Dr. Cohnheim, of Berlin, on the identity of the pus- and white blood-corpuscles thus obviously presenting itself, I proceeded with the following experiments. Drawing a drop of blood from the tip of my finger upon a "growing slide," I covered it with thin glass and placed it upon the stage of the microscope. After finding a white blood-corpuscle showing well-marked granules, I raised the objective, and arranged a fine filament of thread from the reservoir filled with fresh water to the upper edge of the cover, and a fragment of wet paper to the lower, according to the usual method for securing a constant current beneath the thin glass. On depressing the body of the instrument and bringing the corpuscle again into view, I found it still adhering to the surface of the cover, notwithstanding the torrent of red globules hurrying over the field, and as these became paler and less distinct by reason of the diminished density of the serum, the white cell first gradually expanded and displayed its delicate wall with two rounded nuclei, then, after acquiring the magnitude of about $\frac{1}{1700}$th of an inch, it exhibited the rapid and incessant movement of its contained molecules, and finally, when its diameter reached about $\frac{1}{1400}$th of an inch, it burst suddenly, discharging a portion of its contents, whose outbreak resembled that of a swarm of bees from a hive, and some particles of which, actively revolving as they went, swam off to the confines of the field. On repeating the observation and allowing some of the aniline solution to flow in with the water after the first few minutes, the nuclei were strongly stained and rendered beautifully distinct, although the movement of the molecules promptly ceased, in this respect as in all the others showing a precise identity with the reactions afforded by the pus- and the salivary corpuscles, as above described. It should be noted that a certain variable proportion of the white cells of the blood thus treated exhibited no moving molecules, and *apparently* consisted solely of nucleus and cell-wall.

It is worthy of remark that this experiment amply demonstrates the inestimable advantages of high objectives (which some even yet pretend to doubt), for the remarkable movement of the contained molecules seems to have escaped the attention of Prof. Virchow, the great author of 'The Cellular Pathology,' himself (*vide* p. 181, Chance's translation, 1863). Although the observation was first made with the aid of a $\frac{1}{25}$th, yet *afterwards*, knowing exactly what to look for, I had little difficulty in demonstrating to various gentlemen the revolving molecules thus brought into view with powers as low as the $\frac{1}{4}$th inch.

A portion of fetid pus from an abscess, and a specimen of mucus from the nasal fossa, under a like treatment, gave similar results, which did not materially vary in numerous trials.

Tracing now the white blood-corpuscle from its condition of irregular outline and amœbaform movement, as observed in serum and in heavy urine, when the circumambient fluid approaches the density of 1028, through its rounded form with slightly more distinct nuclei, in the liquor puris, and in urine of lower specific gravity, we find that immersed in a rarer liquid, approximating to the mean density of the saliva (1005), it has an accurately spherical outline, is more than twice the magnitude, and contains a number of minute actively moving molecules, thus exactly resembling in all sensible characters the true salivary corpuscle; and it therefore seems reasonably certain that the blood, under the appointed nervous influence, congesting the buccal mucous membrane and associated glands, moves slowly enough through their capillaries to allow some of its white globules to penetrate the walls of the vessels, as they are said to do those of the frog's mesentery in Cohnheim's experiment (Virchow, 'Archiv,' Band 40, S. 38, u. s. w.), which, under the influence of the rarer saliva, expanding them and setting free to move their contained molecules, constitute the bodies so long known to histologists as the corpuscles of the salivary fluid.

Dr. Lionel Beale, in his work on the 'Microscope in Practical Medicine,' remarks in reference to the examination of the saliva—"In the somewhat viscid matter of which the salivary corpuscle is composed, are multitudes of highly refracting particles in incessant motion. The nature of these particles is extremely doubtful. They look very like the germs of bacteria, and it is possible they may be of this nature." If the hypothesis thus guardedly indorsed by the celebrated English microscopist be correct, it seems not im-

probable that the white corpuscles, either in the capillaries or lymphatic glands, collect during their amœbaform movements, those germs of bacteria, which my own experiments ('American Journal of the Medical Sciences,' July, 1868) indicate always exist in the blood to a greater or less amount. And further, it appears not impossible that, when thus loaded, their elimination through the saliva, under the mercurial influence, and their evacuation by a discharge of pus from a seton or a tartar-emetic ulcer, really constitute that therapeutic value of these remedial measures in certain cases which has so long rested unexplained.

On Some Freshwater Rhizopoda, New *or* Little-known.

By William Archer.

With Plates[1] XVI and XVII.

The microscopist, in the course of his examination of his gatherings made from pools and ditches, be the objects of his research what they may, cannot fail to encounter certain ordinary representatives of the group, to some new or little-known forms of which, I am, in the following communication, very cursorily about to draw attention; and this, indeed, rather by hardly more than simply pointing to the figures, than by assuming to throw upon them an additional light by any special observations.

Although the Rhizopoda are a group of which the sea harbours the greatest variety, as well as the most beautiful forms, yet are those which find a habitation in the fresh waters far from being without their interest—nay, few other animal groups have of late awakened more lively attention. Therefore such a communication as the present—even though it but humbly essays to bring to notice some types which seem rarely or not before to have met observation in the fresh water, without being able to add to our knowledge in a physiological point of view as regards these lowly beings—may not, perhaps, be wholly destitute of value or interest.

Such, indeed, is the frequency with which certain freshwater forms are met with, that no observer with the microscope can fail to be more or less familiar with the commoner species; again and again they present themslves, and, to my eyes at least, they seem again and again ever recognisable;

[1] The two folding coloured plates (XVI, XVII) illustrating this paper, will appear in October with the rest of the paper and drawings.

and this strikes me, indeed, so forcibly that I, for my part, cannot at all coincide with those who hold the view that there is no fixity or definiteness amongst these beings, and that all the varied forms—some more, some less abundant—which present themselves are but simply phases of one and the same protean rhizopod.

Such being the views which an at first casual, and afterwards more special, examination of these beings had impressed upon me, I naturally began to think it probable that the types of rhizopods of the fresh waters might not be altogether confined to the ordinary ones already recorded in books, represented by the genera Difflugia and Arcella, Euglypha, Cyphoderia and Trinema, Gromia, &c.; and though evidently the fresh waters are by no means so rich in types or in individual forms as the sea, still my look-out for novelties was not altogether unrewarded.

The state of knowledge of the structural and developmental affinities of the known types is as yet so imperfect that existent arrangements of this group to be found in books are still unsatisfactory. This circumstance renders it a matter of difficulty in bringing forward the following new or little-known forms, to determine exactly with which to begin, although these, indeed, may hardly exceed a dozen. Still they demand several new genera for their reception. The comparative fewness of generic types in the fresh waters renders the intervals between them seemingly wider than if the species were as numerous as those of certain marine groups. The sequence in which I shall put them before those who take an interest in such forms is, therefore, a matter of the less importance. I shall then commence with two forms which come the closest to the marine 'Radiolaria' of Haeckel, by reason of possessing solid parts or skeleton[1] (for none of them actually belong to that extensive group, so lavishly rich in marvellously beautiful forms, by reason of the absence of the seemingly all-important part of the organization—the 'central capsule'), and then I shall pass on to other 'shell-less' forms more approximating to the ordinary Actinophrys, leaving for the latter part of this communication the consideration of another series showing affinities rather in the direction of the Gromidæ and of the Difflugiæ. I shall first venture to offer some remarks on the forms as they thus present themselves, and defer special generic and specific descriptions to the end of my communication.

[1] Haeckel, 'Die Radiolarien (Rhizopoda radiaria)', pp. 25, 69, 243.

Acanthocystis Pertyana, sp. nov. (Pl. XVI, fig. 1.)

Acting on the plan alluded to, the first that presents itself is a little rhizopod lately detected by me, one amongst the most minute, but one, at the same time, seemingly very well marked. It does not, however, demand a new genus for its reception, as it falls, as will be seen—in my opinion, at least, as a new species—under the genus Acanthocystis (Carter).[1] But whilst this is the base, there is just a possibility, indeed, that our form may be really identical with one of Perty's, and referred by him to Actinophrys under the name of *Actinophrys brevicirrhis*;[2] but the data given by that observer being scanty, and the figure not sufficiently explanatory, this must remain somewhat a matter of doubt. But that the present form can be identical with Perty's is, after all, not at all likely, though possible, inasmuch as Claparéde and Lachmann quote a form, which they refer to *Actinophrys brevicirrhis* (Perty), as common about Berlin;[3] and it is hardly likely that the whole three observers would have fallen into the error of taking the present form as belonging to Actinophrys at all.

Before, however, drawing more special attention to Perty's form, or that forming the subject of this communication, it will be advisable to allude to Carter's genus Acanthocystis, thereupon to describe my animal, and afterwards to compare it with that of Perty.

The type of Carter's genus is *Acanthocystis turfacea*, a form not uncommon in our moor pools, though never abundant. At a first glance, and under a moderate power, it might be taken for a green Actinophrys, as the long spines, standing out from the circumference of the globose body, look like pseudopodia, but a closer examination reveals that these are rigid, deciduous, discoid at the base, and bifid at the apex, and I am disposed to agree with Carter that they seem tubular. They ordinarily occur of two distinct lengths, one set of these being long and averaging in length more than the diameter of the body, the other set short and hardly averaging a third of the length of the longer ones. The periphery of the body seems to be covered by a stratum of short, somewhat curved spicula, held together in some not readily perceived manner into what Carter called a 'lorica,' and enclosing the sarcode body. The pseudopodia stand forth in all directions, of necessity issuing from amongst the

[1] 'Annals of Natural History,' 3rd Ser., vol. xiii, p. 36.
[2] 'Zur Kenntniss kleinster Lebensformen,' p. 159, t. viii, fig. 7.
[3] 'Études sur les Infusoires et les Rhizopodes,' p. 450.

spicules; they are very slender, filiform, hyaline, occasionally showing minute granules, and are in length rather more than twice that of the longer set of spines. It is, however, so far as my experience of this form goes, rare to find this creature with the pseudopodia extended; possibly, however, the specimens may require to be some time at rest upon the slide to induce them to project their pseudopodia, or it may require some happy combination of circumstances, as regards the illumination, to bring to view objects of so great tenuity and often of considerable transparency. The sarcode body is almost always more or less densely loaded with chlorophyll-corpuscles, sometimes amylaceous-looking granules, besides those colourless granules always noticeable in the Rhizopoda. I cannot say that I have been able to perceive a nucleus, the existence of which is queried by Carter, neither have I seen contractile vesicles, and I imagine the temporary, somewhat conical projections of the 'lorica,' adverted to by Carter, may be due rather to mechanical disturbances of the globular form than to the action from within of any such pulsating movement.

In connection with the *Acanthocystis turfacea*, I have noticed a somewhat remarkable circumstance, which is, perhaps, sufficiently curious to warrant description. What I allude to is its becoming, in some unexplained way, the *nidus* for the development of the ova of a minute unascertained rotatorian, and I have noticed this circumstance sufficiently often to show that it can hardly be considered as exceptional or unusual. One sees an Acanthocystis with a portion of the green body-matter still normal and healthy, and the rest of the space occupied by one or two colourless ova, or considerably more frequently one sees three such ova, and then the whole or nearly the whole of the body-matter of the Acanthocystis vanished. At first glance this might be thought to look like a developmental state of the rhizopod itself. But on watching one showing this condition, before many hours one may see the beginning of life in one of the ova before the rest; with amazement one watches, and presently there shapes itself out, not a young rhizopod, but a little rotatorian (not unlike a Monolabis). By degrees the young animal assumes more and more of a definite figure, and, like all young rotatoria just ready to leave the egg, seemingly very impatient of confinement. By repeated knocking and shoving headforemost against the wall of the ovum, it ultimately succeeds in bursting the shell, and so it reaches to the cavity of the Acanthocystis. But it is still in prison there. Its narrow bounds, although soon, perhaps, likely to have the

companionship of a couple more of its own species about to be born, would by no means satisfy its roving propensities. Now, the circumferential spicules of the Acanthocystis cohere in some way into a tough strong stratum, making a kind of integument, which only gives way upon force by an irregular rent. One meets such remains of defunct examples of Acanthocystis now and again. Our young rotatorian now repeatedly dashes headlong against this remaining barrier between him and freedom. Well done! little fellow! he has burst his prison-walls and swims away rejoicing, and already begins to pick up his 'crumbs' in the ocean (to him) upon the slide. I presume we must regard the rotatorian as wholly a usurper here—in a great measure, a parasite. Can the germ of the rotatorian grow at the expense of the material of the body-mass of the rhizopod, which evidently vanishes to have its space occupied by the former? Only when there are three, however, does it ordinarily all disappear. How do the ova originally come there? How can the mother-rotatorian deposit her ova, ichneumon-like, within the ill-fated Acanthocystis, for the 'lorica' of Carter seems intact?

This genus differs from Actinophrys in the possession of a skeleton, from Clathrulina[1] in the possession of two distinct kinds of loose portions of the skeleton, and not a hollow perforate globe; nor can such a type be referred to any of the marine genera of Haeckel, owing to the absence of the all-important character—the possession of a 'central capsule.' In fact, Carter had no other alternative than to make a distinct genus for his *Acanthocystis turfacea*, which species has hitherto been the only one known, and hence the type of the genus.

It may not, therefore, be without interest to draw attention to a second form in a genus which, while it is shut out from the marine forms, has no very immediate relative in the fresh waters, at least so far as the characters to be drawn from the skeleton are concerned.

The form, of which I now venture to refer to a rough sketch, fig. 1, has occurred to me in one or two places only, near Carrig Mountain, Wicklow, and at first glance I took it for a possible rotatorian ovum; for, until I made a second gathering from the same source, presenting a greater number of examples, I had not the good fortune to find a specimen with the pseudopodia extended. But a brief inspection even of specimens not exhibiting the pseudopodia satisfied myself that it was no ovum I had before me, but a true rhizopod.

[1] Cienkowski, in 'Schultze's Archiv für Mikroskopische Anatomie,' Bd. iii, Heft iii, p. 311, 1867.

In the first place, I noticed that the short, slender, tapering and pointed rays were not always vertical, but lying in various directions. I saw too, shortly, in some specimens, that they were readily shed, and then that they were capitate at the lower end. A little more pressure, and the little, short, slender, peripheral bodies became evident and readily removable. All this could not happen were this body a rotatorian egg. In fact, without any hesitation, I felt satisfied I had before me a new form referable to Carter's genus Acanthocystis, which diagnosis was fully confirmed on finding examples fully displaying pseudopodia. I could never see any trace of either 'nucleus' or vacuole. It, of course, struck me that this form might have been previously encountered, and that there was a possibility of the spines being taken for pseudopodia, which they, no doubt, at first resemble, and on reference to Perty's work a form presents itself, as has been mentioned (l. c.), with which this may possibly be really identical, though I fear the data afforded are by no means sufficient to decide this point. But if my form is, in fact, Perty's *Actinophrys brevicirrhis*, nothing can be more certain than that he has misapprehended the characters presented, and that for a time, like myself, having seen only specimens with the pseudopodia not extended, he has mistaken the spines for pseudopodia. A further ground, too, is given to this assumption by his figure showing some of the rays (not to call them either spines or pseudopodia) as variously directed, not truly vertical. My form has, moreover, greenish contents, though I have not seen any of so great depth of colour as in *A. turfacea*. But he gives no good indication of the peripheral spicules in his drawing. Be this as it may, I feel satisfied that my animal finds its true place in the genus Acanthocystis, and as commemorative of Perty's labours, I have pleasure in naming this little form *Acanthocystis Pertyana*.

Raphidiophrys viridis, gen. et sp. nov. (Pl. XVI, fig. 2.)

On the occasion of my first chronicling in the "Minutes of the Dublin Microscopical Club" the discovery of this fine rhizopod, one of the most noble, probably, to be found in fresh water, I designated it as of a type roughly definable as an Actinophrys *plus* spicula. But it is actually of a structure more differentiated in some respects than that expression would convey, for if we would imagine an Actinophrys densely studded at its periphery by some unknown agency with a multitude of such acicular spicula as occur in this species, we should have something like it, it is true, but

we should still have to imagine a further amount of differentiation effected in the body-structure before a type would be produced similar to that now under consideration. Nay, if we could even conceive some fairy power able to effect both such imaginary alterations, there is no known Actinophrys, even so quasi-generically transformed, that would deceive any one who had seen our form as to its being exactly the same species—that is, there is no Actinophrys that offers a basis for the fanciful manufacture which I have supposed of one and the same thing; for, even imagining it carried out, we should have but a pretence of a new and distinct Raphidiophrys — not anything to be mistaken for our *Raphidiophrys viridis*. But away with fancy.

I have taken up this form next after the foregoing Acanthocystis, because by the possession of spicula, though but of one kind, it seems, like it, very closely to approximate to the marine Radiolaria; like Acanthocystis, however, it wants any trace of a 'central capsule.' If, indeed, it possessed that organ, I do not see any character which would exclude it from the marine genus Sphærozoum (Meyen), Haeckel.

In endeavouring to convey a general idea of our form (Pl. XVI, fig. 2), for its exact generic and specific description I shall, as before, defer to the end of my communication, it may, perhaps, be better that I proceed, as it were, from within outwards.

In the first place, then, we have a variable number, say from one to a dozen or more, of balls of pellucid sarcode matter, about $\frac{1}{350}$ of an inch in diameter, of definite outline, not containing any nucleus (that I can detect), but each bearing just under the periphery a dense stratum of somewhat large chlorophyll-granules, leaving the centre of the globes free. These globular, definitely bounded masses of sarcode, each so enclosing its stratum of chlorophyll-granules, are (in the next place) surrounded by a common investment of a more cloudy, very pale, or slightly buff-coloured sarcode matter, and of a more changeable character. Occasionally one meets, but rarely, however, examples with but a single central globe, and, indeed, those with two or three only are uncommon; some six or eight are more frequent, and such examples are quite large enough to be visible to the naked eye. One meets some sometimes of very considerable size with comparatively numerous globes. Proceeding outwards, we find that, immersed in this general sarcode envelope, are contained an immense number of very slender, hyaline, acicular, siliceous spicula, acute at each end. These are numerous beyond all computation, and so densely crowded that they do not

individually occupy any definite direction, but are found tossed about, as it were, reminding one of a loosely tumbled-up heap of pins (without heads, however, and pointed at each end). These never encroach into the substance of the inner globes. Emanating from amongst these spicula, lastly, proceed in every direction very numerous, closely-set pseudopodia, which are exceedingly long and quite straight, of immeasurable tenuity, quite hyaline, and not seemingly carrying granules. The opacity of the outer stratum, with its abundantly crowded spicula, along with the great fineness of the pseudopodia, together prevent our making out whether the latter take their origin from the inner globes or from the outer stratum. I imagine, however, so far as I can see, as well as from analogy of a form hereafter to be drawn attention to, that they proceed from the contained inner globes directly through the outer stratum.

I have said that the spicula do not assume any definite position, but this is hardly always correct, for shortly after a specimen of this form is placed upon a slide for examination, and after it begins, as it were, to recover the shock of the transference, certain of the external spicula do begin to assume a more vertical or radial position, especially subjacent to certain of the pseudopodia. Along these they become crowded and lie up against them, forming around each of such a somewhat conical aggregation. They thus form a kind of involucrum (so to speak) to the pseudopodium which they invest, of an elongate-triangular outline, from the apex of which projects the pseudopodium afar into the water. Not all the pseudopodia become so notably surrounded by these clusters of spicula, but only a number, distributed at somewhat even distances, present this appearance, whilst the majority start off from the outer periphery of the rhizopod, from amongst the general crowd of spicula, without becoming specially surrounded by a cluster of them. Such a description would seem to attribute to the spicula an independent power of change of location and of mode of arrangement; but although, in watching an example of this rhizopod as it expands and gradually assumes its characteristic appearance under the microscope, it would almost seem as if some out of the dense mass of spicula spontaneously underwent a certain amount of arrangement as described, this, however, must be of course attributed to the mobility of the sarcode matrix itself forming the outer stratum in which they are imbedded causing them passively to yield to its outward changes of figure. It must be this outer stratum of soft sarcode which, by sending out long conical projections around certain

pseudopodia, causes the spicula to assume a position with their length lying in the direction of the very gentle force produced by their gradual elongation.

I should mention that this is a very fragile and, during manipulation, easily distorted organism; under even a slight pressure the outline of the inner balls gets lost or even broken, and the chlorophyll-granules, outer stratum, spicula and all, become confused into one indistinguishable mass; it therefore requires some care to place one of these under the microscope for due examination, and it should be guarded from too great pressure, and allowed to remain on the slide for a little to enable it to recover the shock sustained by its removal from the water; and often one finds, with all care, that a number of the spicula will be shed, without, however, otherwise injuring the specimen.

The spicula of this rhizopod are not exactly either fusiform or cylindrical, but rather seem to present one side more curved than the other. They are not, however, at all falcate, but straight and pointed at each end; yet in conveying an idea of their shape it may possibly assist some to say they present an outline somewhat like the straight cells of the minute alga, *Ankistrodesmus falcatus*. They do not seem at all to be hollow, thus unlike the "spines" of *Acanthocystis turfacea*, and they resist the action of strong acid.

The pseudopodia, on the most careful scrutiny, do not, at least to my eyes, show any trace of a current; they are colourless and rigid, never coalescing one with another. The chlorophyll-granules in some specimens I have examined have shown very much of a starchy appearance; I regret that I have not yet made the experiment of adding sulphuric acid and iodine.

From finding examples with one hollow-globular, central mass only, though uncommonly, and others with various, up to considerable numbers, it is readily conceivable that these must increase in number, and the group thus enlarge in size, by the repeated division of the central balls. And, in fact, I have taken specimens in which some of these balls were still held together by broad sarcode processes or by a single narrow isthmus-like connection, some of the chlorophyll-granules occupying the space intervening; sometimes these families themselves cohere into compound clusters, seemingly associated by a union of the pseudopodia, thus forming comparatively large groups; perhaps, rather, this may be the result of a separation of the larger groups into smaller, each retaining a share of the large balls and of the outer investing stratum, with its spicula. Except when so injured by pres-

sure or such accident, the chlorophyll-granules do not extend beyond the boundary of the inner balls.

I regret to say I have not found any other indication of a reproductive process, nor have I ever seen any trace of incepted food, though I have taken specimens at all seasons of the year.

This must be accounted a rare form ; the distinct situations in Co. Wicklow, in which I have found it, are, perhaps, not as many as six, and the individual pools not quite twice that number, yet in some of these I almost think I should hardly fail to get examples, with perseverance, at any season. But although thus seemingly restricted to spots, and never abundant, I fancy this fine form may be more widely distributed than we imagine, for only the other day I saw at least two examples from near Glengariff, but they were poor ones. A large example, with a little experience, can be seen by the unassisted eye, like a greyish-green dot, almost as large as some specimens of *Actinosphærium Eichhornii*.

I shall again advert to this organism and its position in a future part of this communication.

Cystophrys Haeckeliana (Pl. XVII, figs. 1 and 2). and *C. oculea*, gen. et sp. nov. (fig. 3.)

The next type, which presents itself under two forms, is destitute of the hard parts characterising the two preceding, and thus recedes further in that regard from the true Radiolaria of Haeckel; but, though wanting in anything which might be called skeleton, there is a part of the organization presented which calls to mind the 'yellow cells' pervading the majority of that great group, so rich in multitudinous forms. But whilst there is seemingly a community of characters in the two rhizopods now to be drawn attention to, I am not, indeed, myself yet quite satisfied that they ought truly to be regarded as congeneric, owing to the seemingly diverse character of their pseudopodia, but still, for the present at least, it is desirable to leave them together. As in the previous instance, I defer to the latter part of this communication the special generic and specific descriptions of the forms drawn attention to, giving for the present merely a few cursory remarks upon them.

I shall first advert to the form which I first met with, though, as experience has shown, it is greatly the more rare.

The rhizopod which I have named *Cystophrys Haeckeliana* (Pl. XVII, fig. 1), is of an irregular, though normally of a roundish figure, possessing, immersed in the body-mass, a

number (often very great) of spherical cells, with dense granular contents enclosed in a special wall, and each with a nucleus and nucleolus, these cells forming a subglobose internal cluster; they, however, sometimes are more or less scattered, and even separated into minor groups. These central cells are pretty much of equal size, though occasionally a few somewhat smaller or larger than the average—about 1-1700 of an inch—present themselves. The nucleus appears to be usually, if not always, excentric, with an excentric nucleolus; but the nucleus is sometimes not evident, most probably owing either to the cell-contents being too thick and dense to admit of its being seen through, or to its being turned away from that side which is towards the observer. The nucleus appears of a light colour, and with a very delicate boundary, and the nucleolus shows itself as a somewhat darker dot therein posed somewhat to one side. The general cell-contents are of a granular appearance, and of a greyish-blue tint, very like that of the so-called 'nucleus' in Amœba, Difflugia, &c. &c. The cell-wall is thin and sharply defined, and presenting a somewhat yellowish tint; the contents not unfrequently are seen considerably receded from the wall, and possess a smooth boundary or outline. Self-division of the contents takes place by a complete fission into two within the outer wall, and often in such a stage a nucleus is to be seen in both parts of the so-divided mother-cell; but I cannot say what becomes of the parent cell-wall upon the young cells attaining full form, nor whether they acquire a special cell-wall ere they should in any way become denuded of the mother-cell-wall. The sarcode mass enveloping the cells is of a very great tenuity and very delicate, hence the covering-glass, in order to preserve so fragile an organism for due examination, requires to be kept from bearing too heavily upon it, by being let down upon a piece of thin glass, or some such mode of defence adopted, or by placing the dip in an animalcule-cage, when the amount of pressure is thus under control. Emanating from this delicate sarcode mass the pseudopodia project to a greater or less extent into the surrounding water; these sometimes attain a considerable length, probably twice the diameter of the body or more, and are then fewer in number than when they are more shortly projected, and sometimes do not radiate in all directions; they are sometimes rather short, and then more numerous, and then usually radiate more or less copiously all round. They are slender and pellucid, and mostly branch in a more or less irregular and subarborescent manner, becoming also not unfrequently mutually incorporated here

and there in a reticulose manner. The branching takes place mostly near the base, but sometimes one presents a somewhat tufted appearance near the upper extremity. Although very slender and colourless, the pseudopodia sometimes show distinctly the passage of very minute granules, and occasionally show slight protuberances or expansions at various points along their length. All these characters I have tried to portray in the figure (Pl. XVII, fig. 2). Their motion or change of form is ordinarily slow and somewhat languid, but is constant, for, although persistent looking at them in an endeavour to trace their changes step by step is a draft on one's patience, still, upon a few moments' suspension of observation of them, and on again viewing them, very perceptible changes will have been seen to have taken place, not only in the branching and extension of the pseudopodia, but also in the mutual disposition of the group of central cells. But it certainly takes some amount of protracted observation to perceive all this—that is, the modifications of form characteristic of the rhizopodous nature. However, the presence of foreign bodies entangled in the substance is not uncommon, in this respect unlike Raphidiophrys, in whose substance never yet any foreign bodies presented themselves.

But if the slowness of the motion or change of figure of the pseudopodia should at all raise a doubt that we had a true rhizopod before us, and not actually some vegetable production which the cells might call to mind, the encompassing of so unusual and so comparatively unmanageable a subject of attack as a portion of a fibre of wool by a fine specimen of this noteworthy form, which I witnessed, would settle the point. A fibre of wool happened to be in the dip made from the gathering and presented itself upon the slide, and in close contiguity to it a large specimen of this new form, copiously filled with the central cells, and abundantly spreading forth its pseudopodia, not quite so much so, however, as in other specimens I had seen. By degrees, I think more by accident due to some external force, probably exerted by myself in slightly modifying the position of the covering-glass, the rhizopod and the wool came into contact. I waited with curiosity to see what it might do. The rhizopod first spread itself down along the wool, and the central cells, in place of forming a rounded cluster as at first, became distributed in a crowded drawn-out series. Meantime the pseudopodia by degrees began to disappear along the sides, but to present themselves in increased force upwards and downwards along the wool, as it were seemingly mooring the rhizopod to the wool. Presently these reached quite up to one end of the

wool, and the sarcode mass seemed to follow, until finally the wool was wholly covered by it at one end, the mooring pseudopodia disappearing at each end, whilst the general sarcode seemed to become stretched so as to envelope the wool. As the animal became thus extended along the fibre of wool which it had thus to a great extent incepted, it, of course, became somewhat more tense, and hence the wool took a curved or bowed figure, and the sarcode mass became stretched straight across the concave side, but thinly disposed along the convex, which is the state I have tried to represent in the accompanying drawing (fig. 2). During this elongation of the sarcode mass the central cells, now disposed in a nearly single stratum at the upper and lower ends, or even isolated, seemed in other places to have become extruded beyond the outline of the sarcode body. But, though seemingly thus expelled, they did not separate; and I conclude that they must have been removed beyond a certain region only of the sarcode body, that which presented the outline whose tenacity caused the bending of the wool, and that there must have been an outer stratum of a very hyaline character and great tenuity which was able to retain the so partially extruded central cells from becoming wholly cast off. However inert, then, this organism when first detected under the microscope, and however great resemblance to some vegetable form which it might present under a low power which might not reveal the existence of the pseudopodia—nay, hardly even render it very discernible, without some practice, from some of the Protococcaceous forms which presented themselves in most of the gatherings in which this form was found—yet such an observation as that detailed demonstrates that this is really a rhizopod, and the amount of energy displayed after coming into contact with the foreign body, as compared with its ordinary comparatively inert state, was very curious to see. I had, however, on the very first occasion I detected this form, quite satisfied myself of its true nature by a prolonged observation.

A consideration of the characters of this lowly creature, simple and few as they may be, yet suggests affinities with its allies not a few, and those various; and, in attempting to draw attention to them, it is a difficulty to what side we should first turn. Of course, it is only amongst the naked rhizopods, or those destitute of a test, that, according to received views of classification, we have to look for its immediate allies. To Gromia our form offers some resemblance in the somewhat branched and not unfrequently inosculating pseudopodia, but they are far finer and more slender; there

is nothing at all like the vigorous flow of the granules along the pseudopodia seen in that genus, nor do they reach anything like a proportional length and size; in fact, in our form they are very slender, and sometimes somewhat silvery in appearance; but, moreover, it differs from Gromia, as I need hardly observe, and to speak of nothing else, in the absence of a test. With the genus Lieberkühnia (Claparéde et Lachmann), it agrees in the absence of a test; but it differs equally widely in the character of the pseudopodia, Lieberkühnia being, so to speak, a Gromia *minus* a test. In our animal the pseudopodia emanate from all parts of the body, from amongst the central cluster of cells, whereas in Lieberkühnia, notwithstanding that the creature's body is devoid of a test, the pseudopodia emanate from a given part only. It is also very greatly larger than our form. I have never been so fortunate as to encounter Lieberkühnia, nor am I aware that it has been met with by any other than its original discoverers.

I have, however, very rarely met with a form in the fresh water, which I would now have little, if any, doubt in regarding to be the same as the so-called *Amœba porrecta* (Schultze).[1] To the description given by Schultze I have nothing to add, save that, if my identification be correct, this form presents in the granular mass of the body an olive colour. With Haeckel I may venture, however, to say that I quite concur in believing that such a form as this cannot possibly be regarded as falling under Amœba; without, however, knowing, as I need not say, anything whatever practically of his genus Protogenes, it is quite possible that it may be far better called *Protogenes porrecta*, but still I fancy there is a considerable affinity to Lieberkühnia, notwithstanding that in the *porrecta* the pseudopodia emanate from everywhere or anywhere, and not from a single part only of the surface of the body. Neither have yet shown a nucleus or contractile vacuole. I mention this form here, however, whilst likewise drawing attention to its resemblance to some extent to our new form, to say that I by no means would regard the latter as the same thing *plus* the cells—that is, as any state of *porrecta* loaded with what might possibly be regarded as reproductive cells. Whilst there is, no doubt, a resemblance, the mode of branching form assumed by the pseudopodia in each is sufficiently characteristically different, at least to my eyes, and as, I think, an inspection of both Schultze's figure and that which I have made of my *Cystophrys Haeck-*

[1] Schultze, 'Ueber den Organismus der Polythalamien,' p. 8, t. vii, fig. 18; Pritchard, 'Infusoria,' p. 550, pl. xxi, fig. 3.

eliana will sufficiently indicate. Hardly anything can be prettier than the gradual expansion, under one's eye, of an example of the form referable to Schultze's *A. porrecta*, presenting itself first as a little shapeless sarcode-lump, and then extending into a wide-spreading, reticulose, densely ramifying combination of several little trees, under a higher power quite filling the field of view.

From the naked forms represented by the more familiar Actinophrys, the subarborescent character of the pseudopodia would alone readily distinguish our rhizopod, even though it did not possess the central cells. In our new form there does not appear any body or structure equivalent to the so-called 'nucleus,' as that term is applied to the peculiar body in Amœba, Difflugia, and some other forms to be described hereafter in a future part of this paper. The absence of a test shuts out this form from a few whose pseudopodia may otherwise resemble it. There is, moreover, in our form no 'contractile vesicle.' As regards, then, other rhizopods destitute of a test, it is distinguished from Actinophrys by the subarborescent character (so to call it) of the pseudopodia and by the central cells. From Raphidiophrys, whose pseudopodia are still more delicately slender than those of Actinophrys, and do not fuse at all, it is distinguished by the absence of the spicula and the presence of the central cells—in fact, the possession of the central cells shuts our form out from every other fresh-water genus, not to speak of the other wide distinctions drawn attention to.

It might suggest itself, then, as I have alluded to, that these very central cells might point to an affinity of the marine forms comprised under Haeckel's 'Radiolaria,' that is, if the cells in our form were thought to be at all the representatives of the so-called 'yellow cells' which pervade that great group, with the exception of Haeckel's family therein—the 'Acanthometrida.' As we have seen, these central cells are, like the 'yellow cells' of the great majority of the Radiolaria, true 'cells,'[1] in the strictest sense or application of the word; that is to say, they possess a nucleus, nucleolus, contents, and a wall, and so do the 'yellow cells,' as described by Haeckel; and, what is equally important, both agree in the mode of self-division of the contents. In short, the central cells in the rhizopod now brought to notice are, if the expression be allowable, to all intents and purposes, homologous with Haeckel's 'yellow cells,' except that they are not of a yellow colour; at least, not yellow, contents and all, as depicted by Haeckel, yet still the cell-wall has a

[1] Haeckel, op. cit., p. 84.

slight greenish-yellow hue, whilst, however, the contents have that greyish-blue tint very like that of the so-called 'nucleus' in Amœba, &c. But, even admitting that the central cells of our rhizopod be so far comparable with the yellow cells of the marine Radiolaria, it could not possibly be admitted into that great group at all, owing to the total want of a 'central capsule'—this latter being a part of the organization of the Radiolaria of Haeckel which is common to every member of the whole of that marvellously beautiful class.

If, indeed, our animal had a central capsule, it would seem easy to show a relation to such marine forms without skeleton of any kind, as Thalassicolla and Thalassolampe, or Collozoum; but being destitute of that organ it must remain by the side of Actinophrys, Raphidiophrys, Clathrulina, Acanthocystis, and other less allied fresh-water Rhizopoda, until, perhaps, a greater number of types become known, or until more is made out of the development of these humble existences, and a light shed upon their real affinities. It will be seen, however, that upon a comparison and contrast with its seemingly nearest allies, it offers characters showing affinities in various directions, but at the same time forbidding its finding a place, so far as I am aware, in any known genus.

As regards the 'yellow cells,' Haeckel suggests that they may have something to say to the function of digestion. I am at least strongly inclined to suppose that in the present form the central cells must subserve rather to reproduction. But on this point I am without any but too cursory observations to be worthy of record. Let us, however, hope that this animal may turn up on some other occasion—perhaps at the same season next year—although, as will appear, it is readily overlooked; but I should not be without hope of refinding it, as I met with it in several gatherings in Callery, and in one from near Carrig Mountain, though, on the other hand, a more recent gathering from one of these localities did not reveal it.

I now refer to the second form, *Cystophrys oculea* (n. s.), which, provisionally at least, I would associate with the foregoing; I have tried to reproduce it in fig. 3. It will be seen that, whilst it agrees in having a number of central cells, it differs in the character of the pseudopodia, which here are fine, linear, directed in various ways, and do not branch or inosculate: and this is the principal reason why I imagine that it is possible they should not fall under one and the same genus, for I think the nature of the pseudopodia is, generally speaking, very characteristic in these forms.

Again, I have not satisfied myself that the cell-like structures occupying the mass of the body are really cells—that is, I have not seen that they possess a special wall, though the bright spot in each, with its central black dot, may, most probably, be regarded as nucleus and nucleolus, and homologous with the white space and darkish dot in centre of the cells of last form. These bodies in the present are of that bluish hue and granular appearance prevalent in such forms. The central nucleus, so to call it, is of a circular or broadly elliptic outline, and is bounded by a distinct, sharp, black line; its colour seems to vary, and this, with the kind of illumination and of the state of the focus of the microscope, from a bright yellow to amber and red. When focussed low down it appears red, a shade higher of an orange or amber hue, and focussed high it assumes the colour of a bright speck of flame. Viewed under a moderate power the colour evinced is reddish, the quantity of these bright specks giving a red character to the whole creature. There is generally but one of these bright dots in each, but occasionally two in certain of them which present a more elongate outline, perhaps indicating self-division, as in the last form. With a certain position of the focus the black dot is evident in the centre of nearly all these bright eye-like specks. The general sarcode mass of the body often closely envelopes the central cells, and at times the figure of the creature approaches the globular, though elevations and various distortions frequently occur. Sometimes, however, specimens are met with comparatively poor in the central cells, and the rather hyaline sarcode body-mass can then be seen; and such can undergo a multiplicity of shapes, and the creature presents an activity and locomotive power quite surprising, if one's acquaintance with this form should be made with the globular inert condition. I have several times, in watching the movements of a freshly-taken lively specimen, seen it actually tear itself into two, and each portion become rounded off, and survive as a distinct but smaller individual; and this for no evident reason, that is, quite spontaneously and even rapidly. A triangular cleft makes its appearance at one margin, which becomes deeper and deeper; but this cleft is not a complete severance of the sarcode at each side, for it remains connected by numerous fine linear threads, just like the marginal pseudopodia, except that for the present they remain connected at both ends with the body-mass. Presently the tear extends downwards, and the slender sarcode threads give way at the upper part of the cleft, some remaining to belong to one of the separated margins, some to the other. This

cleft proceeds until the two portions of the original body-mass remain connected by but a very narrow isthmus, which finally tears across. The adjacent parts of the margin of each of the now two distinct *rhizopods* do not as yet seem to possess the pseudopodia quite so abundantly or so long as the older external margins, but in a few moments no difference is observable, and we have two smaller rhizopods out of one, and shortly at a considerable distance from one another.

I would parenthetically remark here that I could not at all look upon such a process as this as in any way to be regarded as a reproductive one, and yet this is all that Haeckel attributes to his "*Protamœba primitiva*," and calls by that name, notwithstanding that, in his most interesting paper he is not satisfied to regard a process quite so simple as a reproductive one in any other form.[1] What he describes for his form seems to be nothing more than an accidental fission into two, and cannot be regarded in either his or the present form as a reproductive act. Examples of what I assume to be doubtless the *Protamœba primitiva* are met with in many puddles, and I would have imagined them to have been but undeveloped conditions of Amœba itself. In *Cystophrys oculea*, as well as *C. Haeckeliana*, it is possible that the central cells may subserve to reproduction.

Heterophrys Fockii (Pl. XVI, fig. 3), and *Heterophrys myriopoda*, gen. et sp. nov. (Pl. XVII, fig. 4.)

Had it not been for the 'yellow-cell'-like structures appertaining to the two preceding rhizopods, allocated by me to the new genus Cystophrys—thus, *perhaps*, bringing them in that regard somewhat close to the marine Radiolaria—I should have preferred taking up the two forms here placed under a new genus, Heterophrys, immediately after Raphidiophrys. For although these latter have neither spicules nor any organization that might be assumed as comparable to 'yellow-cells,' they yet seem to me, apart from the spicules, to come pretty close in other respects to Raphidiophrys. Still, the important character of the presence of the spicules in that genus, and their absence here, would forbid their being ever united in one genus. The two forms now under consideration, each, however, in a diverse manner, present characters in their structure which reduce them both to a single type, at the same time offering an amount of

[1] Ernst Haeckel, "Monographie der Moneren," in the 'Jenaische Zeitschrift für Medicin und Naturwissenchaft,' Band iv, Heft i, p. 107. (Translated *ante* in this Journal.)

speciality separating them from any other heliozoan genus. The absence of a 'central capsule,' of course, excludes them from Haeckel's marine Radiolaria.

As it seems to me, however, that the subsequent of these forms met with by me approximates the more closely to Raphidiophrys, whilst that first found (or Focke's form) comes nearer Actinophrys, I shall advert to the former in the first place, although the second in point of time of being encountered.

As previously, it will be more convenient in the present running commentary to take up the examination of the structure of each from within outwards, as Focke, indeed, has done in regard to that which I conceive to be identical with his form.

We find, then, in the form which I name *Heterophrys myriopoda* (Pl. XVII, fig. 4), a ball of sarcode of about the same average dimensions as in Raphidiophrys, hyaline, sharply bounded, and charged with a similar dense stratum of somewhat large-sized chlorophyll-granules, arranged in a hollow-globular manner beneath the periphery of the orbicular sarcode body, with a few colourless minute granules besides, sometimes showing a dancing movement. From this body are given off not very numerous, comparatively stout, slightly tapering, filiform pseudopodia, some of which are sometimes somewhat dilated at the base or origin. Surrounding this globular central body an outer stratum presents itself, of a somewhat buff-coloured hue and cloudy granular appearance. One can to some extent recognise three different regions in this investing stratum, not at all separated, however, by any decided line of demarcation; at the lowest part, or that nearest to the central body-portion, it is more cloudy and somewhat more granular in appearance than a little higher up, where it gradually assumes a more homogeneous condition until towards the upper third of its depth, where this sarcode investment becomes more characterised by a sort of linear arrangement of the substance, the apparent lines assuming a nearly radial direction, until towards the periphery the substance becomes, as it were, slit up into a very great number of fine linear acute prolongations, giving the margin a fimbriated or fringed appearance. These very slender sarcode processes do not all project in a strictly radial manner, for they often lie more or less obliquely, and sometimes appear as if they originated more or less in a kind of tufted manner, thus giving the fringe-like margin a somewhat irregular appearance. The pseudopodia emanating from the inner sarcode body pass directly through this outer stratum and project, some of

them, a distance more than twice the diameter of the body into the water.

The pseudopodia never seem either to branch or coalesce, nor ever fuse in any way with the substance of the investment surrounding the central sharply defined ball from which they originate. The chlorophyll-granules do not obtrude beyond the bounds of the latter, except very rarely and very few, and this possibly as the result of accident, perhaps a kind of mechanical displacement during an act of either inception or of ejection of food, although I have not seen any crude food in any of the specimens I met with. Of course, an undue pressure on the whole will squeeze it into an indistinguishable mass, the chlorophyll-granules become scattered about, and the contour of the inner body quite obliterated; and yet if the pressure be but comparatively slight the creature has the power gradually to recover its form and symmetry and project its pseudopodia and expand its border almost as before. Those who inspect the figure of this form (or, indeed, of the others also) will, of course, understand that the drawing is made from a specimen focussed down to its equator, as it were, and that the continuation of the investing portion intervenes between the inner globe and the observer, as well as at the margin (and, of course, behind); for, when focussed as the figures are drawn, the substance of the outer stratum is sufficiently transparent to offer no obstacle to the passage of the light, and we are enabled to see the body and its radiating pseudopodia as if it were absent; when focussed up more and more the cloudy outer substance comes into view, and we see by degrees the fimbriated periphery and the pseudopodia revealing themselves.

The inner globe never shows any 'nucleus' nor an enclosed or marginal pulsating vacuole, nor have I ever seen more than one inner globe in each specimen. This is a comparatively dead and inert form.

This form thus agrees with Raphidiophrys in the inner globe possessing a hollow globular stratum of chlorophyll-granules, and in the outer stratum, of a different kind of sarcode, being endowed with a certain mobility. But this latter part of the organization possesses no spicules, a circumstance which, in the opinion of some, might be sufficient to place two such forms widely apart; but there are marine Radiolaria without spicules, or indeed any solid parts. The fimbriated margin, composed of the linear prolongations of the investing sarcode, is absent in *Raphidiophrys viridis*, and in that form this part of the structure seems capable only of sending out longish triangular prolongations, rendering them-

selves evident by piling up the spicules into long peaks around certain pseudopodia. These latter, in the present form, are much coarser, microscopically speaking, than they are in Raphidiophrys.

The second form (Pl. XVI, fig. 3) here to be drawn attention to is one, examples of which I exhibited in September, 1867, at a meeting of our Club, but I did notthen venture to describe it or to give it a name. My attention was recalled to it on the appearance of a paper lately published by Dr. Focke, of Bremen,[1] in which a rhizopod (his "No. 1") which I cannot but consider as identical with the present is expatiated on and figured, but neither specially described nor named. As I feel, however, pretty satisfied that it should no longer remain so, and as the fine form just mentioned (named by me *Heterophrys myriopoda*) seems so truly congeneric with it, I have thought myself quite justified in uniting them under one genus; and whether I am absolutely correct in believing the form now under review as identical with Focke's, I trust he may (should these lines ever meet his eye) pardon the liberty in my associating his name with it, and calling my form *Heterophrys Fockii*. As before, I shall defer a detail of the generic and specific characters to the end of this paper.

Compared with *Heterophrys myriopoda*, this form (*H. Fockii*) is minute, though it occurs of varying sizes. The inner sharply bounded sarcode body, in which I am unable to detect a 'nucleus,' sends forth through the outer stratum long and slender filiform pseudopodia, and, though it contains a subperipheral stratum of greenish granules, they do not appear to be of the nature of chlorophyll, and the body is sometimes colourless, or of the bluish hue not uncommon in rhizopodous forms. The outer stratum is of a somewhat buff-coloured hue, and often of an indefinite outline, and of that somewhat granular, irregularly contorted appearance, as if bearing in its substance bands and little spots of varying nature and density, which gives it that aspect which, in the Club Minutes, I somewhat indefinitely denominated 'streaky.' Believing, as I do, that Focke and I have had the same form under examination, I could not avail myself of what would appear to me a better description, so far as it goes, of the appearance of this outer region:—"Es erscheinen in der Sarcode selbst lichtere und trübere Stellen, zarte geschlängelte Fädchen, sehr kleine Körnchen, hin und wieder ein grosseres Bläschen, zeigen eine Begrenzung

[1] Siebold and Kölliker's 'Zeitschrift für wissenschaftliche Zoologie,' Bd. xviii, Heft 3, 1868. "Ueber Schalenlose Radiolarien des süssen Wassers," by Dr. Gustav Woldemar Focke.

durch schwache Shattenlinien, welche stets in dem Augenblicke, wo man sie schärfer ins Auge fassen will, wieder verschwinden." This outer region often possesses no very definite outline or contour; it frequently presents, however, a number of marginal triangular, irregular, changeable projections, the 'tongue-shaped' processes of Focke, and which I have endeavoured to depict; and at other times these disappear, when the contour becomes altogether indefinite and its substance undefinable. These tongue-shaped processes seem quite comparable to the long triangular elevations in the outer region of Raphidiophrys, which bear up the spicules in somewhat longitudinally arranged clusters; but in this form, as in the previous, this portion of the structure encloses no spicules.

This species occasionally presents itself cohering into more or less definite groups of a few individuals by union of the pseudopodia; or a few of the inner globes, as is the rule in Raphidiophrys, are surrounded by the common outer investing stratum. It possesses a considerable power of change of place.

In one of his figures Focke points to the appearance or indication of a contractile vacuole,[1] but he does not seem to be satisfied as to its actual occurrence. In several specimens which I have met with, one or two, or even three, marginal pulsating vacuoles were present, and I watched their dilatation and contraction, which process is like those of an Actinophrys (Pl. XVI, fig. 3). This circumstance, which has never shown itself in *H. myriopoda*, is one which, so far as it goes, brings this form closest to Actinophrys.

In the following part of this paper I hope to speak of the relationships of these forms, as well as of the new genus Pompholyxophrys (Pl. XVI, figs. 4, 5), which I am obliged to postpone for the present; and I hope likewise to add some account, with figures, of some other new or little known Rhizopoda of Gromian affinities.

(*To be continued.*)

[1] L. c., t. xxv, 1 g.

The Sexual Form *of* Chætogaster Limnæi. By E. Ray Lankester, B.A. Oxon. With Plates XIV and XV.

In vol. xxvi of the 'Transactions of the Linnean Society' is published a paper by me, read in December, 1867, describing, amongst other matters, the general structure of the rapidly-reproducing fissiparous worms found abundantly on Limnæus and Planorbis. At the time when that paper was read I had not succeeded in obtaining these worms in a sexually mature condition, though, as mentioned in a note, I was fortunate enough to do so while the paper was passing through the press. For more than three years I have taken every opportunity of examining the little worms on the water-snails; and it was only last October, during the first week of that month, that I was gratified with the sight of individuals possessing sexual reproductive organs. They were only to be obtained for the space of one short fortnight, and then disappeared. The sexual individuals were larger than the fissiparous forms, which continued to abound, the former being comparatively rare—about in the proportion of one sexual individual to twenty of the chains of fissiparous zooids. The mature worms, which thus so transiently and sparsely make their appearance, present certain very interesting modifications of structure as compared with the immature zooids, which I shall endeavour to point out, though I may here remark that I look forward to a further examination next October, to clear up some matters of doubt; the arrangement of the reproductive organs themselves is also a subject of much importance in these worms, and has not hitherto been satisfactorily stated.

The only accounts of the reproductive organs of Chætogaster with which I am acquainted are to be found in two papers published by M. Jules d'Udekem, a naturalist by whose early death this branch of zoology has lost a persevering and able investigator. In his valuable memoir on the reproductive organs and development of the Earthworm, published in the 'Mem. des Savants Etrang.' of the Academy of Belgium, 1856, vol. xxvii, M. d'Udekem gives a diagrammatic sketch of the genitalia of *Chætogaster diaphanus*. In the 'Bulletins' of the same Academy, vol. xii, 1861, p. 243, he gives another sketch, "very schematic," as Professor Leydig observes, of the genitalia of *Chætogaster Mulleri*, accompanied with a brief explanation, and also a description of

the genitalia of Æolosoma. These are the only notices of the sexual state in the genus Chætogaster that I know of. It is important to state that d'Udekem, in a previous paper in vol. xxxi of the 'Memoirs of the Belg. Academy,' 1858-59, recognised three species of Chætogaster, viz. *Ch. diaphanus* of Gruithiusen; *Ch. Mulleri*, supposed by d'Udekem to have been confused by Müller with *Ch. diaphanus*; and *Ch. Limnæi* of Von Bär. In my paper in the Linnean Society's 'Transactions' above referred to, I have given an account of the synonymy of the species of Chætogaster as far as my knowledge would permit. Having overlooked the reference to Chætogaster in this well-known essay by d'Udekem on the classification of Oligochæta, I had independently come to the conclusion that *three* species[1] of Chætogaster must be recognised; and I feel the more confidence in this conclusion, on finding that the species are identical with those recognised by the lamented Belgian naturalist. The *Chætogaster Mulleri* of M. d'Udekem, which I have found in the river at Oxford, appears to be the *Ch. niveus* of Ehrenberg, under which name I have mentioned it in my former paper. M. d'Udekem expressly states that the sexual condition of *Ch. Limnæi* was unknown to him. What he states with regard to the other two species, *Ch. diaphanus* and *Ch. niveus* (*Mulleri*), will be gathered from the figure (fig. 1); *s. r.* he calls seminal receptacles; *e. v.*, "entonnoirs vibratiles," *i. e.* ciliated efferent ducts; *h*, two "hard pieces" at the opening of the ducts; *ov.*, the ovary. The drawings, both in the case of *Ch. diaphanus* and *Ch. Mulleri*, are very sketchy, and do not give the relations of the organs mentioned to other parts at all. The "hard pieces" were not detected in *Ch. diaphanus*, but only in *Ch. Mulleri*, whilst in the former a clitellus is figured, and the ova are stated to have an orange-coloured vitellus, which distinguishes them readily from those of *Ch. Mulleri*. The ova are said to be formed at various points on the body-wall, and not from a specialised ovary. My observations on *Chætogaster Limnæi* do not agree with these, some differences being doubtless due to the difference of species. I find testes in the position, and somewhat of the form indicated in d'Udekem's drawings as "seminal receptacles." I have completely failed to detect an "entonnoir vibratile," and cannot fix its position clearly from d'Udekem's indications. I do not find the mesial mass of ova which d'Udekem calls ovary; but on either side of

[1] There is also Schmarda's South American *C. filiformis*.

the ventral nerve-cord, in the region of the stomach, rounded masses of ova develop in pairs.[1]

Appearance of the Sexual Forms.—The asexual zooids of *Chætogaster Limnæi*, which are so abundant on the water-snails through the greater part of the year, are rarely more than one sixth of an inch long, and then usually consist of two well-grown individuals, with portions of some four others developing between and behind them; for details of their structure I must refer to my paper in the 'Linnæan Transactions.' In October I observed some of the worms, which appeared to be unusually large, and I accordingly examined them with the microscope. They left the body of the snail when placed in a vessel of water, in a bolder and more venturesome manner than I had ever noticed with the usual small forms, which stick very close to their snail, especially when they are sought in order to be submitted to an examination. One of these large worms gave the following order of bristle-bundles (which I shall henceforth call fasciculi), indicating segments, individuals, and new regions of growth, viz., head with cephalic bristles, followed by *five* well-grown abdominal fasciculi (instead of three with a growing fourth, as is the case in the asexual zooids generally), then a space, and homogeneous matter indicating a region of growth; then *three* very incomplete fasciculi; then another space and constriction; then *ten* abdominal fasciculi, the anterior of which were well grown, the posterior just sprouting; behind this, homogeneous matter and a constriction; and then a head with cephalic fasciculi, followed by five abdominal pairs; after these a constriction and seven abdominal fasciculi, the anterior well grown, the posterior rudimentary. The succession may be written thus:

ceph. and 5 abd. | 3 abd. | 10 abdominal | ceph. and 5 abd. | 7 abdominal.

and compared with a parallel case of an asexual zooid—

ceph. and 3 abd. | 3 abd. | 6 abdominal | ceph. and 3 abd. | 9 abdominal.

The important thing to observe is the succession of five well-developed pairs of abdominal fasciculi in immediate connection with the head in the case of these larger specimens, which I soon found were developing sexual organs; for

[1] M. Claparède, in his most valuable 'Recherches sur les Oligochetes,' accepts d'Udekem's statements as to the presence and position of an efferent duct in Chætogaster. In any case, it cannot be allowed that the hypothetical duct is developed in the *second* segment, as M. Claparède tabulates it, for the pharyngeal region of *Chætogaster* probably *represents* the second and third somites (perhaps more) of other Oligochæta.

in front of the first pair of abdominal fasciculi in each of the zooids represented by a head (the first and fourth group as given above), I saw a pair of rounded masses placed one on each side of the nerve-cord, which were obviously developing ova, and anterior to these were undeniable testes. I afterwards found specimens in which there were still more fasciculi, following in unbroken order a head and cephalic bristles, and at last obtained the worm drawn in fig. 2, which must be regarded as the sexual form of *Chætogaster Limnæi*. No longer remarkable for the small number of its segments, but having, in addition to its anterior region, sixteen or seventeen segments, indicated by as many pairs of fasciculi, this form exhibits, somewhat strangely and instructively, the antagonism between Individuation and Genesis. Whilst the rapid process of fissiparous reproduction is going on, the individual zooid can only be said to consist of a head and four segments, of which the fourth is continually budding in both anterior and posterior direction, separating from its parent by the growth of a new head; but as the sexual completion of the individual commences, the rapidity of the process of fissiparous reproduction is stopped; and the new segments, as they grow, instead of becoming separated from the parent-stock by the intermediate development of heads, remain attached as parts of the whole until the Chætogaster, once remarkable for its paucity of segments, becomes a lengthy worm (about the one third of an inch long) of a head and sixteen or more somites. It may seem, at first sight, wrong to regard the development of sexual organs as belonging to individuation rather than genesis; but it is when contrasted with the period of rapid asexual reproduction that we recognise the development of the sexual condition as implying increased individuation. The nutrition of the growing segments necessary for them to develop heads and separate from their parent is diverted to the commencing genitalia, and, consequently, genesis is stopped, whilst individuation gains, but only temporarily; for by the further development of those genitalia the worm will be so far taxed as to be destroyed, and death will put an end to the individuation altogether.

The change in the number of segments which remain attached to form an individual is not the only change which occurs in the Chætogaster during the development of the reproductive organs. *The number of the bristles in each bundle is nearly doubled.* Whereas, in the asexual zooids seen at other times of the year the cephalic fasciculi contain twelve, and the abdominal eight bristles apiece, I have counted in the sexual form between twenty and thirty bristles

in each cephalic bundle, and sixteen in each abdominal bundle. This is a very striking and curious change, and is in harmony with the numerous facts which establish a direct nutritional relation between the genitalia and tegumentary structures, *e.g.* puberty, the stag's horn and testicle, the plumage of birds, colours of fish, &c. The sexual form also possesses a well-marked cuticle (Pl. XIV, fig. 6), which is represented by the merest pellicle in the asexual condition. I have observed certain appearances, which make me think it possible that the *Chætogaster Limnæi* sheds parts of its skin and bristles during the development of the genitalia; for amongst the specimens I examined in October were very many with a *less*[1] number of bristles than is normal to the asexual forms. In these individuals the genitalia were not yet traceable; but some had only six cephalic bristles in one bundle and seven in the other, in the place of twelve, which is the almost *invariable* number at other seasons of the year; the abdominal bristles were equally diminished, giving the idea that they had fallen out, or been lost in some way. The most curious thing, however, is that in all these cases and in the sexually mature individuals, too, numbers of bristles could be seen occupying the stomach and intestine, undoubtedly swallowed by the Chætogaster. It appeared to me probable that the worm had swallowed its own shed bristles and cuticle; but it is possible that the presence of bristles in the stomach may have been due to other worms having been swallowed—the smaller by the larger individuals.[2] This seems unlikely, because at no other time of the year have I seen these bristles in the alimentary canal of *Ch. Limnæi*, though I have observed them for a long time. I am inclined to believe that there is a shedding of old, as there is certainly a production of new, bristles. Another change with regard to the bristles is in the equality of length of the cephalic and abdominal bristles; whilst in the asexual form the cephalic bristles are about $\frac{1}{200}$th of an inch, and the abdominal about $\frac{1}{400}$th of an inch, in the sexual form both abdominal and cephalic bristles are much larger, in accordance with the greater size of the worm, and are more nearly of an equal length, the cephalic bristles measuring more than $\frac{1}{100}$th of an inch in length. I am also

[1] There is frequently considerable variation in the number of bristles in a fasciculus in the same species among Oligochæta. Thus, in Enchytræus, as remarked by Henle, and in Lumbriculus, Clitellio, &c., as I have observed, to the extent of four in place of seven, or *vice versâ*.

[2] Possibly the sexual zooid on becoming detached from its parent zooid swallows it, since the latter is much the smaller. The *growth* of the sexual zooid has yet to be observed.

inclined to think that the curvature of the bifid hooklet in the sexual form is somewhat less acute than in the larvæ, for so the immature forms may be called. The presence of the thick cuticle, which has been already mentioned, prevents the formation of the rugæ which I noticed in my former paper, and which have so much the appearance of superficial vessels. The increased number of setæ in each bundle is accompanied by an increased differentiation of the muscles moving them. A longitudinal and a horizontal muscular band is distinctly seen in the sexual form attached to each bundle (Pl. XIV, fig. 4). The bristles are frequently thrown into a fan-like curve, so that half have their apices directed anteriorly and half posteriorly (Pl. XV, fig. 3). This appearance, no doubt, would tend to suggest the existence of a double series of fasciculi on each side of the mesial line, which has been stated to exist by Leydig in the genus Chætogaster; but it is quite clear that the bristles are really collected into but one bundle on each side. I have stated this in my former paper; and M. Leon Vaillant, in a recent memoir on Perichæta ('Ann. des Sciences Nat.,' 1868), also emphatically states that he cannot endorse Leydig's description. It is the more necessary to correct this error, since it is propagated in Victor Carus's excellent 'Handbuch der Zoologie.'

Turning our attention now to the viscera of the sexually mature Chætogaster we find but little change to notice (other than the presence of the genitalia). The nervous structures maintain the form observable in the larvæ; the remarkable pharyngeal or stomato-gastric ganglion and commissure, which is so conspicuous in *Ch. diaphanus* (see below) not being represented at all, as far as could be ascertained, even in this more highly developed condition. The muscular fibres passing to the viscera from the body-wall exhibit a very definite nucleated structure. The stomach, or first enlargement of the intestine, showed very frequent undulatory or peristaltic contractions, which are not observed in the larvæ, whilst the cilia of the inner wall are more obvious than in the asexual stage. The intestine expands again after the stomach into a cavity of nearly equal size, which extends as far as the sixth pair of abdominal fasciculi, and then contracts to a much smaller calibre, in which form it persists throughout the tail-like continuation of the body formed by the terminal somites. This disposition of the alimentary canal is, of course, quite peculiar to the sexual form, since in the larvæ it is broken up by constrictions and new growths by the separation of the zooids. The perivisceral cavity contains not any, or but few, corpuscles other than those belonging to the genitalia.

The dorsal vessel is markedly developed; its contractility becomes specialised and confined in great measure to that part which overlies the so-called stomach. Its walls are thick in this part, and contain clear nodular masses, which may be nervous elements, or may act, as they appear to do, as valvular thickenings. They are not dissimilar in appearance to the masses seen in the dorsal vessel of some insects, *e.g.* the Corethra larvæ, and may be compared also with the multicellular valvules mentioned by Leydig in his 'Lehrbuch' as occurring in Clepsine, Piscicola, and Pontobdella.

It will be observed, in the outline figure of the sexual *Chætogaster Limnæi* (Pl. XIV, fig. 2), that the first pair of abdominal fasciculi is represented as overlying the stomach in its anterior half, whereas in the larvæ (Pl. XIV, fig. 3) the first pair always appear at the extreme posterior end of the stomach, or even altogether posterior to it. The range of movement of which the alimentary canal is capable, of course, affects the relations of these parts somewhat, but will hardly account for the exceedingly forward position of the first pair in this case. It would, no doubt, be interesting to ascertain how far the adult Chætogaster is produced in the course of *posterior growth*, and how far its special characters are due to subsequent modification. Not having watched the mode of development of the additional bristles which are present in the sexual form, I am doubtful as to whether this first pair of fasciculi is really the representative of the first pair in the larval condition. It is probably a new development—the *second pair* of the sexual corresponding to the *first pair* of the larval form. The relation to the opening of the first pair of segment organs should determine this point; but my notes are not absolutely decisive on this relation.

In the larval *Chætogaster Limnæi* there is, as I have repeatedly observed, although the specimens measure barely one tenth of an inch in length, a pair of segment organs situated *in front of the first pair* of fasciculi, and opening in front of them, there is also a similar pair in front of each succeeding pair of well-developed fasciculi, connected always more or less with a muscular diaphragm forming the anterior boundary of the segment to which the organ belongs. In *Chætogaster diaphanus*, whilst still in an asexual condition, there is no such large gap between the cephalic and first abdominal fasciculi as exists in the larval *Ch. Limnæi*, nor is there, according to his figure, in the *Ch. filiiformis*[1] (with three bristles in a fas-

[1] Roughly figured—observed in the Andes 'Neue Wirbellose Thiere.' The gap between the cephalic and succeeding fasciculus in *Ch. Limnæi* is

ciculus) of Schmarda. There is also this important fact—that there is no segment organ in front of the first pair of abdominal fasciculi in *Ch. diaphanus*, the first segment organ lying between the first and second abdominal fasciculi. So also in the sexually mature *Ch. Limnæi* there is no trace of a segment organ in front of the first pair of abdominal fasciculi—that is, so far as my notes go: it is, of course, difficult to establish the *absence* of such delicate structures. Hence, then, I am led to infer, not only from the forward position that the first pair of abdominal fasciculi in the sexual *Chætogaster Limnæi*, and in *Chætogoster diaphanus*, are not the homologues of the first pair in the *larval Ch. Limnæi;* but the same conclusion is also supported by the disposition of the segment-organs. A further piece of evidence in favour of this view is found in the existence of structures identical with the "hard pieces" of d'Udekem (Pl. XIV, fig. 1), in close proximity to the first pair of abdominal fasciculi in the sexually mature *Ch. Limnæi*. They are drawn in fig. 8, Pl. XIV, and were observed in two different specimens. They are evidently setæ or bristles modified for some generative function. When it is remembered that d'Udekem indicated the "hard pieces" in *Chætogaster Mulleri* as placed at the orifices of the ciliated efferent ducts which he figured in that species, it becomes clear that if any segment organ exists in this position in the adult *Ch. Limnæi*, it should be one modified so as to form an excretory generative duct. I am certain that such a duct did not exist in the specimens I studied, nor I believe any representative of a segment-organ. It appears to me to be possible that at a later stage of development than I had the luck to see efferent ducts may develop in connection with the modified setæ observed by the side of the first pair of abdominal fasciculi in the sexual *Ch. Limnæi*.[1] In this case it would seem not unlikely that the first pair of fasciculi, the modified setæ and efferent ducts, may one and all be new developments of the generative region, which in the larvæ are as completely unrepresented as are the generative glands themselves.

This question, as well as the later stages of reproduction, I must hope to clear up next October.

clearly due to a suppression of intermediate fasciculi. The apparent cephalisation is thus caused; the cephalic bristles are not more truly cephalic than the first pair in *Nais*, but their separation from the next pair gives them a false significance. Their differentiation as to *number* and *length* is, however, a true claim to distinction, and is an important zoological character.

[1] The scattered condition of the star-like masses of spermatozoa in the body-cavity (see fig. 7, Pl. I) is very much against the probability of an efferent duct developing itself.

The great difference in size between the sexual *Ch. Limnæi* and the fissiparous larvæ which abound through the year must not be overlooked. I believe that the larvæ are smaller in the earlier months of the year, not when measured by the length of the chains of zooids, which are very long when found *within* the Limnæus in February, but estimated by the breadth and the size of their setæ. In September they appear to be getting bigger; and at last, in October, the sexual forms are developed, measuring a maximum of one third of an inch for a head and sixteen fasciculi, as against one tenth of an inch in the larvæ for two attached zooids, consisting each of a head and seven fasciculi, the posterior of which belong to new growing zooids. I may here also observe that the rate of production of new zooids probably varies with the abundance of nutriment, and that in some cases you may see as many as four or five segments (indicated by fasciculi) remaining attached behind a head without sign of separation; but, as a rule, you will observe separation taking place after the third abdominal pair of fasciculi.

Generative Organs.—Having above described the changes occurring in *Ch. Limnæi* on assuming the sexual state, other than those relating to the genitalia themselves, I shall now describe these. In a specimen which consisted of two individuals developing sexual organs and intermediate and terminal zooids in a state of growth, I endeavoured to fix the position of the generative organs in relation to the muscular septa which pass from the body-wall to the alimentary canal, and which in most Annelids agree with somites or segments in number, though I doubt if they do in the anterior region of Chætogaster. I noted—1, septum below the pharynx, followed by the commissural vessels (see former paper); then, 2, a thinner septum, between which and 3, a similar septum, was a doubly pyriform mass of considerable size, cellular structure, and transparent. This double mass, or these two masses, were the testes, as was most clearly proved afterwards. They appear to have been mistaken by d'Udekem for "seminal receptacles" (Pl. XIV, fig. 1), since he figures no testes, but organs to which he gives the above name in the position of what, there can be no doubt, are testes in *Ch. Limnæi*. After septum 3 came two round masses of ova, one on either side the nervous cord; below these the first pair of abdominal fasciculi; the modified setæ (hard pieces) had not yet appeared in this specimen. Then followed septum 4, between which and septum 5, which was a large, well-marked septum, was a pair of segment organs opening in front of a pair of fasciculi,—the *second abdominal fasciculi* of this sexual form, the

first, as I believe, of the larva. At septum No. 5 the stomach ended; that is to say the dilatation of the alimentary canal ceases, a great contraction occurs, and a second expansion follows, forming what may be termed intestine, for the sake of distinction. Between septums 5 and 6, 6 and 7, and 7 and 8, there was a pair of segment organs and a pair of fasciculi, in each case. These were followed by homogeneous blastema, and the commencement of another zooid, to which succeeded a third zooid, developing sexual organs like the first. In the course of time, no doubt, each of these zooids would complete itself by developing the full number of sixteen or seventeen segments, perhaps even a larger number than I saw in the specimen, Pl. XIV, fig. 2.

The Testis.—The testis is seen in Pl. XIV, figs. 5, 7. In the first case it is immature, in the second figure it is in a worm apparently quite adult; fissiparity had entirely ceased; the worm had the appearance given in fig. 2; and the generative products, both ova and spermatozoa, were floating freely in the body cavity. The large spheres of which the testis is at this time composed appear to be thrown off, as they become complete, into the perivisceral cavity, where they assume the form (fig. 7), the well-known actinophrys-like masses of spermatozoa. These pass down the body to some distance, making their way so far as the third or fourth pair of abdominal fasciculi. There certainly appeared to be no efferent duct in connection with the testes at this period of maturity. Whether a pair are developed, or how the spermatozoa escape, is unknown to me.

The Clitellus and Genital Setæ.—The clitellus extends from in front of the first pair of abdominal fasciculi to behind the second pair. It consists of cells having the appearance of Pl. XIV, fig. 9. The presence of a clitellus implies copulation; but the only other copulatory organs are possibly the stunted bristles which develop near the first fasciculi. To these remarkable organs I propose to give the name of genital setæ.[1] A clitellus implies copulation, if the usual explanation of its function is correct; but it seems to me to be quite as well suited to the purpose of forming an egg-capsule as to aiding copulation—in fact, rather better. In the Earthworm it probably is useful in sexual congress; but it by no means follows that because such is its function, or a part of its function in the Earthworm, that such is its function elsewhere. An existing

[1] I have recently observed similarly modified setæ in *Nais*, which develope as a new pair of fasciculi, indicating a segment unrepresented in the asexual form. Thus the existence of distinct larval and mature forms is established for gemmiparous Oligochæta.

structure may have its function largely changed to meet a want in the organism; and it has yet to be proved that the Limicolæ use their clitelli in copulation, whilst a "capsulogenous gland," as d'Udekem termed certain internal glands, is wanting in many cases. Hence, I think, we cannot infer any very intimate or elaborate copulation from the presence of a clitellus.

The Ova.—The ova appear in round masses, paired on opposite sides of the neural cord. Their appearance may be learned from the figures. At first only the anterior masses appear. Subsequently in two cases I noticed a second small pair—that is, a younger pair, developing *posteriorly* to the first pair of abdominal fasciculi. There was no oviduct perceptible. The ova floated in masses in the most mature individual I observed, in the perivisceral cavity; one ovum had grown much larger than the others in the same mass, as is very usual among Oligochæta. The ova drawn in Pl. XV, fig. 4, were each about $\frac{1}{100}$th of an inch in diameter. The ova arise in the protoplasmic matter surrounding the nerve-cord, by extension of which same matter the homogeneous blastema is formed from which the head and somites are produced in zooid-growth. The masses of ova commence as detached protoplasmic masses, in which arise feebly defined nuclei, apparently few in number at first, but increasing in distinctness till there are seven or more visible on one surface, each with surrounding differentiated matter. The ova so developed simply hang together, not supported by any framework, and are easily detached from their position when their growth has proceeded some time. The simplicity of these ovaries is equaled by that of the testes, in which the sac-like figure disappears with development, and simple masses of spermatozoa are detached in numbers from an aggregated mass, as they become ripe and float freely in the body cavity. The masses of ova and the masses of spermatozoa thus floating are strictly comparable. The enormously greater relative abundance of spermatozoa, as compared to ova, is very striking. Their *mass* is even far greater. What special purpose does this serve in the worm's adjustment to its conditions?

As to how the ova escape from the body, how they are impregnated, how they develop, what may be the first appearance of a young Chætogaster, as also the time and place of his *début*, I have as yet not the slightest indication. The interesting change from larva to adult, which is paralleled amongst Polychæt, but not recorded amongst Oligochæt Chætopoda, makes one anxious to know the whole history of this minutest of the class. I cordially recommend

the upper reservoir on lower Hampstead Heath to those readers who wish to get abundance of both *Chætogaster Limnæi* and *Chætogaster diaphanus*.

Classification.—In vol. xxvi of the 'Linnæan Transactions,' p. 744, speaking of the zoological position of Chætogaster, I remarked, in reference to the genera Chætogaster, Parthenope,[1] Thysanoplea, and Æolosoma, "they are now put with the Naids, from which certainly Chætogaster differs as much as Nais does from Lumbricus."[2] The classification here indicated has been since advocated by M. Leon Vaillant in his interesting paper already alluded to ('Ann. des Sciences Naturelles,' 1868). M. Vaillant proposes, as primary groups of Oligochæta, these, viz. Lumbricina, Naidina, and Chætogastrina. The limitation of Lumbricina given by M. Vaillant is, perhaps, not quite what could be wished, his Naidina and Lumbricina forming more naturally *four*, or at least *three*, families; but I believe the family Chætogastrina to be well justified. M. Vaillant places in it Chætogaster and Ctenodrilus (Parthenope). It is this Parthenope which made me hesitate to propose a family for Chætogaster; for it has not the specialised cephalic fasciculi of Chætogaster (Schmarda's Chætogaster from South America seems also to be in this case, and further agrees with Parthenope in its having only three bristles in a fascicle), and thus seems to bridge over the chasm to Naidina, its ciliated prostomium and spotted integument also helping on the way through Œolosoma. Nevertheless, its uncinate bristles in single series and neural position, and its general form, agree with Chætogaster. We cannot hope or reasonably expect that throughout the organic world Nature should destroy some forms and keep others going, precisely in such a way that those at present existing may form genera, families, orders, or classes at all comparable to one another in size or significance. A finer scale for indicating the gaps between various groups is *now* needed than any suited to the philosophy which regarded species and classes as divine institutions, but allowed men to speculate as to the less sacred "families" and "orders." In the assemblage of forms known as Vermes this fact is strikingly exemplified; and in the construction of the genetic tree of that group Chætogaster will

[1] This is Schmidt's genus; it is identical with Claparède's Ctenodrilus, a fact which M. Vaillant appears to have overlooked. In Pl. XV, fig. 9, I have given a sketch of the worm.

[2] "The gap between Nais and Chætogaster is not so great as I thought when writing as above. The great difference is in the suppression of fasciculi in the pharyngeal region of Chætogaster. In other matters they are closely allied, *e.g.* genitalia, form of setæ, vascular system, &c."

have to occupy a distinct position among the earlier Chætopods, tracing its ancestry first to a progenitor of Parthenope, and through this to the stirps of Æolosoma and the Naids.

Summary.—The following facts, with regard to the sexual form of *Chætogaster Limnæi*, may be regarded as certainly ascertained.

1st. The sexual form makes its appearance in October, and is then but rare. It exhibits greater activity than the larvæ.

2nd. It is from twice to three times as large as the small larval chains of zooids, which measure from one tenth to one sixth of an inch in length.

3rd. Sixteen or more segments bearing fasciculi of setæ succeed in unbroken order to the head and cephalic fasciculi, forming a tapering individual worm, instead of three (temporarily five sometimes) such segments in the larvæ.

4th. The alimentary canals of the adults and adolescent contain setæ which have been swallowed.

5th. The adolescent have often but *half* the number of setæ prevalent in the larvæ (twelve in cephalic and eight in abdominal fasciculi); the adult have invariably *twice* the larval number of setæ in each fasciculus.

6th. The first pair of abdominal fasciculi are situated more anteriorly than in the larvæ, with whose first the second pair agree, not only in position, but probably homologically.

7th. A thick cuticle exists, which is absent in the larva.

8th. A general advance in the histological structure and specialisation of the viscera is apparent in the adult; but the pharyngeal portion of the nervous system retains its simplicity.

9th. There is a bilobed testis situate near the œsophagus, the spermatozoa from which float in masses in the perivisceral cavity when complete.

10th. Ova develop posteriorly to the testes in paired masses on the sides of the nerve-cord; they also are detached and float in the perivisceral cavity.

11th. Close to the first pair of abdominal fasciculi, at the inner margin of each, are developed four stunted and thick bristles of generative function.

12th. A clitellus surrounds the region of the worm about and between the two first pairs of abdominal fasciculi.

13th. Some of these changes arise by *modification* in a worm already grown. How far any arise in the course of *growth* is not ascertained.

Chætogaster diaphanus.—In Pl. XV, figs. 5, 6, I have sketched roughly the nervous system of this species. Leydig

has figured the parts given in fig. 5 in his work on the nervous system of Annulosa. The presence of the second commissure or nerve-collar (*stg*) is very remarkable. It is not present in *Ch. Limnæi*, or, if represented, not sufficiently differentiated from the surrounding tissue to be apparent. In the larvæ of *Ch. Limnæi* the nerve-tissue is homogeneous. The chain of ganglia drawn from the first subœsophageal is important in connection with the question as to the number of somites intervening between the cephalic bristles and the first abdominal fasciculi. It is not till we get as far down the cord as that lettered 1 *br.* (in connection with the first pair of abdominal fasciculi) that the normal form of ganglion, which persists throughout the rest of the body, commences. Two normal ganglia are probably represented by *œ* and *st* respectively on the œsophagus and stomach, and hence, it may be inferred —two somites, which have become fixed and modified into this intra-fascicular region; but it seems that this is not a necessary conclusion. We may suppose that this region never has been or would be segmented, and that its ganglia are due, not to an arrested or fused condition of tertiary aggregation, but to development of ganglionic nerve-tissue at various points in the nerve-strand of a secondary aggregate—that is to say the secondary aggregate to which each segment of Chætogaster partially corresponds in an arrested condition (*i. e.* minus a head). The separation into gangliform masses in the nerve-cord from *sphg.* to 1 *br.* may indicate *superinduced* and not *constitutional* segmentation. The separation of these two forms of segmentation is a matter of great difficulty, and, at the same time, most important for the morphology of the Annulosa, and equally for that of the Vertebrata.

NOTES *on the* THYSANURA. By Sir JOHN LUBBOCK, Bart., F.R.S., V.P. Linn. Soc., &c. &c. (Abstract of Paper, No. 4, read to the Linnean Society.)

SIR JOHN began by adding four more species to the list of British Thysanura, which now comprises about fifty species, of which only fourteen were recorded as British when he began to study the group. Three out of the four now added are Continental species; the fourth does not agree with any

as yet described. He then made some remarks on the reproduction of lost parts, especially on the reparation of wounded antennæ. He showed that if an antenna is cut off, for example, in the middle, it never again recovers the normal number of segments, and he mentions the curious fact that among the species with longest antennæ it is extremely rare to find a full-grown specimen in which these organs are perfect. It is also remarkable that the reproduced segments acquire an abnormal length. Thus, for instance, if a Tomocerus has the terminal and part of the third segment removed, the terminal segment is never reproduced, though the penultimate one acquires a greater length than in unmutilated specimens.

Sir John then described the internal anatomy of the Thysanura, alluding successively to the digestive, respiratory, nervous, reproductive, and muscular systems. In opposition to Nicolet, he denied the existence of Malpighian vessels or of tracheæ. The latter point is one of much interest, and the more so, perhaps, because, as Sir John pointed out, while the majority of the group has no well-developed system of tracheæ, in Smynthurus, on the contrary, they are easily visible. Sir John dwelt at considerable length on the arrangement of the muscles, especially describing the mechanism of the spring and of the ventral tube.

He then made some remarks on the classification of the Thysanura. He pointed out that the Lepismidæ and Poduridæ were much less nearly allied than had hitherto been supposed; and he considered that the Poduridæ, Smynthuridæ, and Lipuridæ formed a well-marked and distinct group, characterised specially by the presence of the gastric tube, to which he attributed greater classificatory importance than to the saltatory appendage.

Finally, he expressed the opinion that this group, though nearly allied to the true Insects, differed more from the Coleoptera, Lepidoptera, and other typical orders of insects, than these groups do from one another.

On Several New *and* Rare Species *of* Fresh-water Diatomaceæ *discovered in* Northumberland. By Arthur Scott Donkin, M.D., Lecturer on Forensic Medicine to the University of Durham, and Physician to the Sunderland Infirmary and Dispensary.

With Plate XVIII.

In pursuing my investigations with the view of publishing, at no distant period, an entirely new work on the British Diatomaceæ, I have recently met with several highly interesting fresh-water species; some of them entirely new to science, the others scarcely known to observers in this country. To a description of these I now beg to direct attention.

In my previous contributions on the Diatomaceæ to the Royal Microscopical Society of London,[1] and to the pages of this Journal,[2] I have fully indicated the localities where immense congeries of marine species may be found luxuriating in their natural habitat on the sandy shore, during the warm months of summer. I now venture to offer a few observations on the localities most favorable to the production of fresh-water species, and the best method of collecting them; but in our search for these we must take our leave of the delights and refreshing breezes of the sea-beach, where—

"Percussa juvant fluctu tam litora,"

and direct our steps to meandering rivers and the babbling waters of mountain streams—

"Quæ
Saxosas inter decurrunt flumina valles,"

with all their fascinations for the student of Natural History.

It is a mistaken assertion, and only applicable to the commoner species, that the Diatomaceæ are almost ubiquitous. On the contrary, many species are extremely fastidious as to localities, while others are only propagated in abundance at certain seasons of the year. Thus the humble *Gomphonema olivaceum* only occurs in the spring, in small clear streams and ditches in exposed situations, covering the stones at the bottom with olive-coloured mammillated cushions, and only in those places where the water is running with some degree of swiftness. Remove a mass of this species from its habitat, and place it in a bottleful of the water in which it was for-

[1] 'Trans. Micr. Soc.,' vol. vi, New Series, p. 12.
[2] Vol. i, New Series, p. 1.

merly growing and expose it to the sun, and it will die in a few hours and become quite bleached—a fact clearly showing that a constant supply of pure cold water is essential for its existence.

Surirella biseriata, *Navicula nobilis*, and, indeed, many other species, prefer the pure spring water of boggy pools on exposed hill-sides. All, indeed, require for their abundant propagation pure water and sunshine, with a certain degree of warmth. Consequently, stagnant pools, overshadowed by bushes and the boughs of trees, are never productive of diatoms, the only species I have ever found alive in water after it had actually become quite putrid being *Cymatopleura solea* and *C. elliptica*; but how long even they could have continued to exist under such conditions I have not ascertained.

Shallow, rapid rivers and mountain streams, and the rills and springs of pure water supplying them, are the favorite haunts of a very large number of species. During a continuance of dry, warm weather in spring, summer, and autumn, they are propagated in surprising abundance on the sandy or gravelly bottoms of gently running pools, or in the quiet eddies by the margins even of rapid streams, or of shallow pools distant from the main stream, and subject to the inundation of floods, at other times supplied with water percolating through the sand or gravel. In all these localities a plentiful supply may be obtained by scooping up the coloured stratum at the bottom with a spoon, and separating the sand from the diatoms by subsidence, and, if a sandy instead of a muddy portion of the bottom is selected, a gathering will be secured unmixed with impurities, and exceedingly rich. In the daytime, especially in sunny weather, the stratum of diatoms at the bottom is floated, by the air bubbles generated and entangled, to the surface in broken masses or flakes, which may be collected from the surface by a spoon, and placed in bottles. These flakes floating on the surface being quite buoyant, are wafted by the breezes into the main current, and are carried downwards by the stream; so that there is no better method of securing a supply of a great variety of species than walking by the side of a river and collecting the brown, jelly-looking flakes as they float onwards on its surface, to be finally deposited in the mud of its estuary, from which some of the species of which it is composed may afterwards chance to be collected, and described as brackish water forms.

The species forming the subject of the present memoir were discovered in localities such as I have indicated, and in

the manner I have described, the splendid form *Navicula Coquedensis* having been obtained in the flakes floating on the surface of a pool.

The gatherings made in the rivers Coquet and Breamish, both mountain streams flowing from the Cheviot range, bore a striking resemblance to those from several localities in the North of Scotland, containing in abundance several of the species found in them, as described and figured by the late Professor Gregory in this Journal.[1] Amongst these I may mention *Navicula cocconeiformis*, Greg., *N. bacillum* Ehr., *N. nodosa*, Ehr., *N. integra*, Smith; *Stauroneis ovalis*, Greg., and *Surirella tenera*, Greg., besides two beautiful forms hitherto only found as British species in Ireland, namely—"*Surirella Caledonica*, Ehr. (*S. turgida*, Sm.) and *Cymatopleura plicata*, Ehr. (*C. Hybernica*, Sm.), the former in considerable abundance.

The invention of the binocular microscope by Mr. Wenham, has introduced a most important aid to the study of the Diatomaceæ, inasmuch as it enables us to obtain a correct knowledge of the form and construction of the silicious frustule and its valves, previously impossible with the monocular instrument. What a striking impression is produced in viewing for the first time under the binocular a valve of *Heliopelta*. How very different the configuration of this truly beautiful species really is, from the illustration of it, as seen by the monocular, given in the plate forming the frontispiece to Dr. Carpenter's valuable treatise on the microscope. The same may be said of many other species, and indeed of whole genera. I shall merely instance another. *Hyalodiscus subtilis* is described amongst test objects in the work just cited, p. 183, as being of a *discoid form*, and having markings which radiate in all directions very much like those of an engine-turned watch. Mr. Ralfs, too, whose accuracy as an observer is sufficiently well known, says of the genus *Hyalodiscus*:—"Its *flat disc* will distinguish it from *Podosira*."[2] Now the fact is that the valve of *Hyalodiscus subtilis* is *hemispherical*, approaching indeed to *conical*, not a *flat disc* as it appears to be under the monocular; while the markings, seen radiating in all directions, are optical illusions produced by the impossibility of getting into focus at a time, under a high power more than a narrow zone of the hemispherical valve. Numerous other examples might be adduced to show that the monocular microscope with its flat field is so unadapted to the study of the diatomaceæ, and

[1] Vol. iv, p. 1; pl. i, 1856.
[2] 'Prit. Inf.,' p. 814.

displays so little of their real contour, that it will be found necessary to reconstruct and redescribe several of the existing genera, and amongst them the genus to which I am about to direct attention.

Surirella, *Turpin*, 1827.

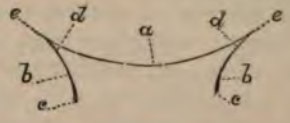
Frustules, free, solitary, with equal extremities or cuneate. Valve with a median longitudinal clear line or space: produced laterally into *carinated alæ*, and folded transversely or obliquely into *plicæ alternately elevated and depressed*: most strongly developed near the margins, and growing fainter towards the median line or space; sides of the valve flexed inwards from the carinæ towards the margin.

Such I conceive to be the generic characters of *Surirella*, which have hitherto escaped recognition, owing, doubtless, to the imperfect observation afforded by the monocular microscope.

This genus was first established by *Turpin* in 1827. *Dujardin*[1] says of his definition, which I have not seen, "M. Turpin voluit faire un genre particulier de celles dont la forme est ovale, presque ronde, et qui sont fortement ciselées; il les nomma Surirella." In 1841 it was restricted by the formation of the genus *Campylodiscus* by Ehrenberg; and still further in 1853 by the late Professor Smith in the construction of the genera *Cymatopleura* and *Tryblionella*. But the characters of *Surirella*, as given by Professor Smith, are by no means exact nor explanatory of the structure of the valve in this genus; he describes the *margins* of the valve as "produced into alæ;"[2] and in defining the genus *Tryblionella* he says "it agrees with *Surirella* in the presence of alæ, but these *arise from the disc and are not, as in Surirella, prolongations of the margin.*"[3] This description and the figures of the marginal views (F. V.) given in Plate viii, vol. i, show that Professor Smith was not aware of the real structure of the frustule and conformation of the valve. The *alæ* are not prolongations of the margin, nor placed at the margin, but are produced by the *abrupt inflection* or folding inwards of the sides of the valve, at a more or less acute angle, some distance from the margin; the point of flexure forming a *carina* on either side. Thus the valve has *three*

[1] 'Hist. Nat. des Infus.,' p. 673. 1841.
[2] 'Synop. of Brit. Diatom.,' vol. i, p. 30.
[3] Op. cit., p. 35.

distinct surfaces externally, as shown by the accompanying figure; *a*, the dorsum, generally more or less concave, and *b*, *b*, the two lateral surfaces. It will be seen, therefore, that the margins (*c*, *c*) are contracted within the area of the expanded alæ (*d*, *d*) which are composed of two folds of the valve, and that the *carinæ* (*e*, *e*) are the points of flexure.



Ideal transverse section of a valve of *Surirella*.

The transverse or oblique "canaliculi" of Smith, or "*costæ*" of Rabenhorst, and others, are the *alternate plicæ* produced by the corrugation laterally of the valve. The plicæ are alternately concave and convex on both surfaces. In the typical species in which the plicæ are semicylindrical—as in *S. biseriata* and *S. splendida*—that which is a *costa* on one surface of the valve is a *canaliculus* on the opposite. The object of this structure appears to be to secure sufficient strength and a certain degree of elasticity, with a small amount of siliceous matter, so as to enable the frustule to float in water.

When a valve is placed flat under the field of the microscope the margins are overlapped by the carinæ, and are thus concealed from view.

1. *Surirella Barrowcliffia*, Donkin.

Frustule panduriform on M. V.[1] and S. V. (and when placed obliquely), with four equidistant, expanded, carinated alæ; carinæ sinuously constricted in the middle and rounded towards the truncated extremities. Valve on S. V. elongated, narrow, slightly panduriform; extremities rounded with a central notch; alæ expanded backwards, panduriform, strongly carinated; plicæ (canaliculi) transverse, wide, semicylindrical; widening towards the carinæ and reaching a short distance within them.

Hab. Fresh water. River Coquet, Elyhaugh; plentiful April and May, 1869.

The panduriform outline of the species on every aspect

[1] F. V., Smith. I prefer M. V., to denote marginal view, or that view of the frustule in which the margins of the valves with the intervening connecting zone are exposed to view. Great confusion in this respect prevails. What is a primary surface with Kutzing, is a secondary with Rabenhorst, and *vice versa*.

in which the frustule can be viewed, together with the notched extremities of the valves, at once distinguish it from every other member of the genus. The central notch at each extremity is produced by the expansion of the carinæ beyond the margin of the valve, so that a groove runs across the truncate extremities from the surface of one valve to that of the other; or, in other words, the groove across each extremity is continuous with the concave dorsum of the valves. I have had repeated opportunities of observing this both in living and mounted specimens.

This form appears to be allied to *S. didyma*, Ktz. ('Bac.,' p. 60, t. iii, 67), and *S. panduriformis*, Raben. ('Süssw. Diat.,' p. 29, t. iii, 8 and 9); but it is difficult to say what is meant by Kutzing's and Rabenhorst's figures. Kutzing describes *S. didyma* as follows: "Oblonga, utrinque truncata, medio sinuato-constricto, margine punctata," and says it is a brackish water species from the Isle of Wangerooge. Rabenhorst more recently ('Diatom. Europ.,' Leip., 1864, p. 51) has referred his *S. panduriformis* to this species; but, according to him, the M. V. is not panduriform, but oblong lanceolate, with truncate extremities; while the valve on S.V. is oblong panduriform, with truncated extremities; the "costæ" being fine, arising from marginal nodules; his description is: *E. minimis;* oblonga, utrinque truncata, panduriformis, a latere oblongo-lanceolata, utroque polo truncata. Costis parallelis gracilibus, e nodulis marginalibus ortis. v. v. Hab. in *aquis submarinis litoralibus* Germaniæ, Italiæ, &c. Mr. Ralfs ('Prit. Inf.,' p. 794) thinks *S. didyma* is doubtfully a *Surirella*. It is, however, a submarine species, according to Kutzing and Rabenhorst; while the present species was discovered in the sandy bottom of a pool, and floating on the surface of a clear mountain stream several miles distant from the sea.

2. *Surirella subalpina*, Donkin.

Frustule on F.V. broad, cuneate; extremities truncated; alæ conspicuous. Valve ovate, elongated; plicæ transverse, slightly inclined near the extremities becoming inconspicuous a short distance within the carinæ, alternately costate on the inner surface of the valve.

This species differs from *S. splendida* and other allied species in the alternate or inner plicæ being narrow and strongly costate; in this respect it bears a close resemblance to *S. limosa*, Bailey. ('Quart. Jour. Micr. Sci.,' Vol. VII, p. 179, Pl. IX, 5.)

Hab. Fresh water. Discovered in abundance in a clear

spring at Ingram, on the river Breamish, mixed with a sprinkling of *S. biseriata.*

3. *Surirella tenera,* Gregory. ('Quart. Jour. Micr. Sci.,' Vol. IV, p. 11, Pl. I, 38.)

Frustule on F. V. elongated, narrow, cuneate. Valve on S. V. elongated, narrow, ovate; plicæ transverse, slightly inclined near the extremities, conspicuous, reaching to the median line, semi-cylindrical; the inner narrow, about 8 in 001″.

Allied to *S. splendida,* but a very much smaller and more slender species, and with much finer plicæ.

This form was described by Professor Gregory as a doubtful species, being under the impression that it might be the perfectly developed *S. linearis.* After ample investigation, however, I feel satisfied that it is a distinct and well-marked species.

Hab. Fresh water. River Coquet, Elyhaugh, May, 1869, frequent. Banffshire, Professor Gregory.

4. *Navicula Coquedensis,* Donkin.

Very large. Valve on S. V. broad, oblong, much inflated in the middle; extremities broad, rotund, slightly dilated; striæ moniliform, connivent, sub-distant from the median line, gradually shortened around the centre, and absent from the extremities; about 30 in ·001″ subdividing dichotomously opposite the centre.

Hab. Fresh water. River Coquet, Elyhaugh, May, 1869.

5. *Navicula vernalis,* Donkin.

Syn.—N. varians, Greg., 'Trans. Micr. Soc.,' vol. iii, p. 12, pl. ii, 14, 15, 25.

Valve short, broad, elliptical, or slightly lanceolate, with broad, rotund extremities; striæ reaching to the median line, distant, robust, obliquely inclined towards the centre; opposite the centre more distant, direct, much shorter, and of unequal length, so as to leave an irregularly triangular blank space on either side of the centre.

This well-marked species appears to have been first detected by the late Professor Gregory in a gathering from Duddingstone Loch, in 1853, and placed by him in a numerous group of forms, which he referred to an undescribed species or type which he named *N. varians.*[1] This group undoubtedly con-

[1] 'Trans. Micr. Soc.,' vol. iii, p. 10, pl. ii.

tains several distinct species, some of them already described as *N. tumida, oblonga, peregrina, acuta, radiosa,* and *scutelloides;* and amongst them the present form, which remains undescribed, although apparently delineated in figs. 14, 15, and 25 in Professor Gregory's plate.

Hab. Fresh water. River Coquet, Elyhaugh. Abundant, April and May, 1869. The typical *N. oblonga* was abundant in the same gatherings.

6. *Navicula Cymbula*, Donkin.

Syn.—*Navicula varians*, Greg., 'Trans. Micr. Soc.,' vol. iii, pl. ii, 33.

Valve elongated, elliptical-lanceolate, gradually attenuated towards the elongated acute extremities; striæ robust, obliquely inclined towards the centre, but becoming gradually direct, much coarser, and much more distant opposite the centre; reaching the median line, and slightly shortened around the centre.

Hab. Fresh water. River Coquet, Elyhaugh, plentiful, April and May, 1869.

7. *Navicula limosa*, Ktz. 'Bac.,' p. 101, T. iii. 50; Grunow in 'Wien. Verh.,' 1860, p. 544, T. iii. 8; Raben. Süssw,' D., p. 41; T. vi. 31; and 'Europ. Diat.,' p. 188. Ralfs in 'Prit. Inf.,' p. 894.

Frustule small. Valve very convex, narrow, linear elongated, with two marginal sinuous constrictions, and three inflations; one central, and two terminal; the central generally the larger; extremities sub-cuneate, obtuse; striæ delicate, transverse, dry valve yellowish brown.

Rabenhorst ('Eur. Diat.,' p. 189) refers the three following forms to this species as varieties:—*Navicula Gibberula*, Ktz. ('Bac.,' p. 101, T. iii, 50*); *N. inflata*, Grun. ('Wien. Verh.,' 1860, T. iii, 8. c.)=*N. Gibberula*, Sm. ('Syn.,' vol. i, p. 51, pl. xvii. 160); *N. bicuneata*, Grun. (loc. cit., fig. 7).

The longitudinal striæ described by Rabenhorst are deceptive appearances produced by the convexity of the valve.

Hab. Fresh water. River Breamish, Ingram. River Coquet, Elyhaugh, plentiful; near Hull, very scarce. Mr. Norman.

I have been induced to give a description and figure of this species, as it is new to Britain.

8. *Navicula firma*, Ktz. (‘Bac.,’ p. 92, T. xxi, 10; Ralfs, in ‘Prit. Inf.,’ p. 909).

Syn.—Navicula affinis, Ehr., *var.* Raben. Europ. Diatom., p. 196.

Valve broad, elongated, linear-elliptical, gradually attenuated into subacute cuneate extremities; striæ close, fine, transverse, reaching to the median line, considerably shortened opposite the centre, moniliform; monilæ elongated, irregular, imparting a wavy, silky appearance to the striæ.

Hab. Fresh water. River Coquet, Elyhaugh, May, 1869.

Kützing first discovered this species in the fossil earth from Santa Fiore in Italy; in this deposit it is quite common. I have slides in my possession of a fossil deposit from Nova Scotia also containing it. The fossil specimens agree perfectly with the recent ones found in the Coquet. Hitherto it has only been found in the fossil state, according to Rabenhorst (‘Eur. Diat.,’ p. 226), and is now added to our recent British species. *Navicula firma*, Smith (‘Synop. Brit. Diat.,’ vol. i, p. 48, pl. xvi, 138), is quite a distinct species, and justly referred by Mr. Ralfs to *N. microstoma*, Ktz. (‘Prit. Inf.,’ p. 909).

The present form was described by Kützing as “*apertura media majori; striis transversalibus nullis;*” but this absence of striæ is only apparent, for though somewhat difficult of resolution, they are very distinct when a good object-glass is employed. It is readily distinguished from *N. microstoma*, *N. amphigomphus*, and other allied forms, by the large central blank area, and by its punctate wavy, silky-looking striæ.

9. *Navicula stauroptera*, Ehr.

Syn.—Stauroptera parva, Ehr. Amer., 1843, p. 135, t. iii, 1, 19. *Stauroneis parva*, Kutz. ‘Bac.,’ p. 106, t. xxix, 23. *Stauroptera parva*, Raben. Süssw. Diat. p. 49, t. ix, 6, and *Pinnularia stauroptera*, Raben. ‘Eur. Diat.’ p. 222. *Pinnularia divergens*, *var.* Greg. Q. M. J., ii, p. 99, pl. iv, 15. *Navicula parva*, Ralfs, ‘Prit. Inf.,’ p. 897.

Frustule small; valve linear, slightly constricted near the broad rounded extremities; striæ oblique, 28 to 32 in ·001″, not reaching to the median line, gradually shortened towards the centre, and finally interrupted, leaving a central cruciform blank area, with four incurved sides, and reaching to the margin.

Hab. Fresh water. River Breamish, Ingram; river Coquet, Elyhaugh, frequent. According to Rabenhorst this species is generally distributed through Germany, Belgium, France, Switzerland, and Italy.

NOTE *on a* NEW MEANS *of examining* BLOOD *under the* MICROSCOPE, *and on the* BLOOD-FLUIDS *of* INVERTEBRATES, *and on a* NATURAL STANDARD *for registering* ABSORPTION SPECTRA. By E. RAY LANKESTER, B.A., Ch. Ch. Oxon.

MY friend, Dr. Arthur Gamgee, last year suggested to me that I should try the new blood-matter, Chlorocruorin, which I discovered in Siphonostoma and Sabella two years since (see Humphry's and Turner's 'Journal of Anatomy,' Nov., 1867) with Day's guaiacum-and-peroxide-of-hydrogen-test (see 'Quart. Journ. Mic. Sci.,' 1868, p. 282). This I accordingly did, and obtained the most satisfactory results, the guaiacum being rendered brilliantly blue in the usual way by the Chlorocruorin and ozonic ether. I also proceeded to try a great number of blood-fluids of Invertebrata. In all cases where the presence of Hæmoglobin (Cruorin) had been proved by me with the spectroscope to be present I did not fail to obtain the blueing of the guaiacum, *e. g.*, in Planorbis, in larva of Chironomus and allied larvæ, and many Annelids. The colourless fluids among these groups I also tested with the guaiacum and "ozonized ether," having been led to suspect that in the colourless blood of insects, molluscs, &c., there must be a body having properties similar to those of Hæmoglobin and Chlorocruorin. The perivisceral fluid of Annelids gave the blue colour with guaiacum, the colourless blood of some insects, crustacea, and molluscs also. In many there was simply an evolution of gas on the addition of the ozonized ether, and no blueing of the guaiacum. I attribute this to the fact that the action was less energetic in these cases than in the case of the red Hæmoglobin or cruorin, which acts far more powerfully with the test than anything else, excepting Chlorocruorin. The mere evolution of the gas is, however, a good test, and can be applied beneath the microscope. Thus, I have been able to bring ozonized ether into contact with very small Entomostraca, and even with some Infusoria, on the microscope-stage, and

observe from *what part* especially the development of gas takes place. The blood-corpuscles may in this way be demonstrated as being the part of vertebrate blood from which oxygen is eliminated in the guaiacum experiment.

When guaiacum is used a porcelain plate is preferable to blotting-paper for the reception of the solution, since it shows any change in the colour more clearly than the paper does.

Reduced Cruorin—that is, deoxodized O, Hb—gives the evolution of gas and the coloration of guaiacum as readily as does scarlet Cruorin or O, Hb; so does Hæmatin, and so does Dr. Thudichum's Cruentin. Hence we cannot conclude at once that it is oxygen held as in O, Hb which is liberated by the loose oxygen of the hydrogen peroxide. The action has to be further inquired into and explained.

Distribution of Hæmoglobin among Invertebrata.—In addition to *Planorbis*, *Chironomus*, and *Annelida*, I have found hæmoglobin lately in insect-larvæ, and, what is more interesting, in a Crustacean, viz., the Phyllopod—*Branchipus stagnalis*. In this latter form it exists in such small quantity as to give but a faint yellow-pink tint to the creature; its presence could never be even suspected by examination with the unaided eye. The spectroscope *at once* demonstrates, beyond the possibility of doubt, the presence of the Hæmoglobin, identical with that found in man. The red colour of many Entomostraca, and of the tail of the male *Branchipus*, is *not* due to Hæmoglobin, though I believe it exists in other Entomostraca, of a pinkish hue. My friend, Dr. Edouard Van Beneden, has discovered a *red vascular* fluid in certain Crustacea, which he is about to examine with the spectroscope, and, I have no doubt, will prove the presence of Hæmoglobin.

It might be supposed that Hb is present in very small quantity in the colourless fluids of Invertebrata which give the guaiacum reaction, and this idea is rather favoured by the small quantity present in Branchipus. The spectroscope would, however, detect a much smaller per-centage than is there present; and there seems every reason to believe, from the intensity of the action in some cases, as, *e.g.*, in the perivisceral fluid of Sabella and of Lumbricus, that it is not in these cases dependent on a small quantity of red Hæmoglobin, but on a colourless allied body, comparable to the green allied body Chlorocruorin.

I may here mention that I have found a species of *Enchytræus*—a genus of Lumbricoid worms supposed to have a *colourless* vacular fluid (Carus gives 'Blut farbloss' as a character of the family)—in which the vascular fluid was quite

red. Henle, in his original memoir on this genus, says that the fluid in mass has a rosy tint. Some Oligochæta have a *very much* smaller per-centage of Hæmoglobin in their vascular fluid than others.

It is noteworthy, as bearing on the function of Hæmoglobin as evidence from comparative physiology, that those Invertebrata in which this body is markedly present, occurring as an exception or in unusual quantity, are forms living in the *foulest mud*, in water sometimes almost destitute of dissolved oxygen, and in which sulphuretted hydrogen and carbonic acid occur in excess. The Hæmoglobin enables them to seize what little oxygen there is. *Planorbis corneus* (an air-breather truly) lives in very foul pools; the larva of *Chironomus* lives in black fœtid slime in ponds; so do many of the Limicolous Oligochæta. *Branchipus* occurs in ponds which are destitute of vegetation, and are more mud than water; it has for companions in the pond on Blackheath *Chironomus-larvæ* and a few Oligochæta, besides minute Entomostraca.

I take this opportunity of pointing out that Preyer's proposed estimation of the exact amount of Hæmoglobin in a solution by the spectroscope is not a practicable thing, since the definition of a band of absorption, with given strength and thickness of solution, must depend on the spectroscope used, some having much better definition than others. Besides this, the personal error must come in very largely in such a method.

Standard for Spectroscopy.—There is a great want of some common and natural standard to which to refer absorption spectra in description. Many valuable observations are lost for want of such a standard, and others are misunderstood. The solar lines are not suitable for various reasons. Mr. Sorby has proposed a quartz plate of given thickness and Nicol's prisms, but it is very difficult to get this apparatus *exactly* made. I venture to propose the red fumes or gas known as nitrogen tetroxide (N_2O_4). This gas, sealed in a small tube, furnishes an excellent standard by which I hope hereafter to describe absorption spectra. There is no difficulty whatever in obtaining or keeping it, and I hope that it may become a general thing to state what relations any bands observed in the spectrum of a new or important body have to those given by nitrogen tetroxide.

The details as to the action of "ozonic ether" on the blood of Invertebrata and on blood products, as also details as to Hæmoglobin, Chlorocruorin, and Chlorophyl in Invertebrata,

and other matters relating to the spectroscope, will be brought forward soon elsewhere.

The dorsal vessel in Oligochæta.—The relation of the vascular system in these worms is, very clearly, primarily to the alimentary canal; the cutaneous vascular system is an additional development. In many cases the contractions of the dorsal vessel contract the intestine simultaneously, and the same movement acts most obviously on the perivisceral fluid, expansion of the vessel acting so as to contract the perivisceral cavity. A similar action is well seen in some Crustacea (*e. g.*, Branchipus); the fluid in the lacunæ *surrounding* the dorsal vessel moves *in one direction* rhythmically with the movements of the vessel. The corpuscles of the perivisceral cavity are, in Oligochæta, *mainly*, but not entirely, derived from the coarsely cellular membrane, which surrounds the dorsal vessel and its branches, and which has been called the hepatic tunic. The corpuscles of the perivisceral fluid furnish good specific, and even generic, characters among Oligochæt worms. We have here a good case of the value of "cell-diagnosis."

NOTES AND CORRESPONDENCE.

Professor Huxley and Dr. Beale on Protoplasm. The eloquent lecture "On the Physical Basis of Life," which Professor Huxley gave before a popular audience in Edinburgh last January, has been made the subject of a somewhat severe attack by Dr. Lionel Beale, in a communication read to the Microscopical Society of London, and published in its Journal for May, 1869. Dr. Beale seeks to show that Professor Huxley has misrepresented the usual meaning of the term protoplasm, or has given it a new and absurd signification in conformity with a preconceived physical theory of life. Meanwhile, there are persons who have been asking, what is protoplasm? Even some of those who should know well enough already. Dr. Beale's attack on Professor Huxley, therefore, complicates matters, since it lends some show of reason to the doubts and difficulties expressed by certain uninformed readers of the 'Fortnightly Review.' I wish here, as an independent student, to state, in opposition to the criticisms of Dr. Beale, that it did not appear to me, in reading the printed lecture of Professor Huxley, that he had used the term protoplasm in any other than its usual, normal, and legitimate signification, and I gather from that lecture that Professor Huxley's definition of protoplasm would probably exclude and include exactly the same things which Dr. Beale's would. Dr. Beale has criticised Professor Huxley's broad and general statements—admirably adapted to the comprehension of a general audience—as though they contained a full confession of his faith *qud* cell structure and histology generally. This, I submit, with the greatest deference to Dr. Beale, is hardly fair; and as his communication to the Microscopical Society appears to misrepresent the views of the highest authority on biological science in this country, I venture, not forgetting the sincere regard which all microscopists must have for Dr. Beale, to reply to the criticisms. Probably, as far as those are concerned who have read the lecture and know Professor Huxley's views and the exceeding improbability of his making the announcements attributed to him, these notes will be superfluous, but there are some to whom they may be useful.

The charges which Dr. Beale makes may be noticed consecutively. He says (p. 279, 'Roy. Micros. Soc.,' May, 1869)—"Still more recently, Von Mohl's primordial utricle has been called protoplasm by Professor Huxley, who, some years before, restricted the term to the matter within the primordial utricle." Again—"I think Professor Huxley is the first observer who has spoken of the cell in its entirety as a mass of protoplasm, and the only one who has ever asserted that any tissue in nature is composed throughout of matter which can be properly regarded as of one kind." Further, Dr. Beale attributes the following notions to Professor Huxley:—"No matter how many different things may be comprised in the cell or elementary part, no matter in what essentially different states these things may be, no matter how different parts may differ in properties—they constitute protoplasm. A muscle is protoplasm; a nerve is protoplasm; bone, hair, and shell are protoplasm; a limb is protoplasm; the whole body is protoplasm. No anatomical investigation is necessary to enable us to detect this substance. Every beast, fowl, reptile, worm, or polyp, that we see is protoplasm. Everything that lives, or has lived, is protoplasm" (p. 282). Leaving out of question Professor Huxley's numerous published writings, in which other views are very fully and carefully expressed, as Dr. Beale admits, I would ask, does the language used by Professor Huxley fairly admit of the interpretation imposed upon it by Dr. Beale? It certainly does not in my opinion, and conveyed no such meaning to my mind on reading the article in the 'Fortnightly,' as it apparently has done to Dr. Beale. The passages from which *parts* are quoted by Dr. Beale, and on which he bases his charges against Professor Huxley, are these:—"Thus, a nucleated mass of protoplasm turns out to be what may be termed the structural unit of the human body. *As a matter of fact, the body in its earliest state is a mere multiple of such units, and in its perfect condition it is a multiple of such units variously modified.* . . . . Beast and fowl, reptile and fish, mollusk, worm and polyp, are all composed of structural units of the same character, namely, masses of protoplasm with a nucleus." "Corpuscles of *essentially* similar structure [to the white blood-corpuscle] *are to be found* in the skin, in the lining of the mouth, and scattered through the whole framework of the body." The italicised words and sentence are not given by Dr. Beale in his quotations, and it seems to me that they imply all which Dr. Beale declares to be ignored. Professor Huxley tells his audience that in development the protoplasm of the structural units becomes *variously modified*, and Dr. Beale ignores this,

though this modification amounts to the difference between Dr. Beale's 'living' and 'formed' matter. Had even no such statement been made, it is impossible to see how Dr. Beale derives his conclusions from what he quotes, when we remember the circumstances under which the lecture was delivered. Again, it certainly does not appear to follow logically that Professor Huxley declares protoplasm and horn to be identical, from his statement that corpuscles *essentially* (that is, in their most important characters, as far as relates to the inquiry in hand) the same as white blood-corpuscles *are to be found* in the skin, &c., which, of course, Professor Huxley was well aware, is largely composed of horny scales, the result of the modification (which he recognises) of the protoplasm.

It may here be noted that Haeckel has not included the simplest animated beings in the genus Moner, as stated by Dr. Beale, on page 282, but that his Monera is a group embracing many genera.

On p. 284 Dr. Beale imputes a view to Mr. Herbert Spencer based on a single quotation from his grand work on 'Biology,' which the whole work does not warrant, and which even the sentence quoted does not seem really to imply:—"The microscope has traced down organisms to simpler and simpler forms, until, in the Protogenes of Professor Haeckel, there has been reached a type distinguishable from a fragment of albumen only by its finely granular character." Distinguishable by the microscope, of course, and by chemical analysis, as Dr. Beale allows, is Mr. Spencer's meaning. Mr. Spencer shows himself always fully alive to the difference of other properties between living and dead matter, and I cannot see what erroneous implication exists in Mr. Spencer's statement.

Professor Huxley compares the chemical analysis of what was once living matter to the chemical analysis of a crystal of calcite, and says, as we call the crystalline form and property an attribute of carbonate of lime, so may we call living form and property an attribute of certain proportions of carbon, hydrogen, oxygen, and nitrogen, combined in a certain but undetermined manner. So in the case of water, we do not suppose an entity, 'aquosity,' to enter into oxygen and hydrogen when they become water: why should we suppose an entity, 'vitality,' for the combination of the elements to form protoplasm? Dr. Beale objects to this (p. 285), that crystalline force is not *identical* with vital force—an objection which he himself terms trivial, and which does not seem to invalidate the utility or significance

of the comparison made by Professor Huxley. With regard to 'aquosity,' he says, "Of water there is but one kind, of protoplasm there are kinds innumerable." It may be replied that there is dirty water and clean water, pure water and water holding matter in solution; if these are not kinds of water in the same sense as the 'kinds of protoplasm,' perhaps it is a distinction of living properties to which Dr. Beale alludes as, *e. g.* between animal and plant protoplasm. There is no reason to suppose that such a difference is not due to a difference of molecular structure, paralleled by allotropy. "The constituent elements of water may be separated and recombined again and again as many times as we please; but the elements of protoplasm, once separated from one another, can never be combined again to form any kind of matter" (p. 286). Much less than one hundred years ago water could not be formed from its elements, as to-day protoplasm cannot in the laboratory; but protoplasm is continually being formed from mineral matters in plants.

Dr. Beale asks, "Are the properties of the elements of dog so different from those of the elements of man as to account for the differences between dog and man?" He seems to imply that Professor Huxley ought to answer "Yes" to this, in accordance with his teaching, and that such a response is very ludicrous. But it is difficult to see what there is incongruous with the scientific knowledge of the day in the supposition that a chemical compound should exhibit a diversity of properties in diverse cases. Returning to the person of his criticism, Dr. Beale says, "Mr. Huxley seems to maintain that protoplasm may be killed and dried, roasted and boiled, or otherwise altered, and yet remain protoplasm." Mr. Huxley did not seem to me to maintain this at all, though, because *special* and *technical* words were not used by Professor Huxley, there is an opening for criticism. Professor Huxley is very careful to speak of mutton, lobster, &c., when eaten, as 'dead protoplasm,' and to ignore the fact that he makes this distinction is hardly just. By overlooking important qualifying adjectives —such as *modified* (see above) and *dead*—an author's meaning can very readily be misapprehended. What Professor Huxley really says and means is seen in this passage:—"Now, this mutton was once the living protoplasm, more or less *modified*, of another animal, a sheep. As I shall eat it, it is the same matter *altered*, not only by death, but by exposure to sundry artificial operations in the process of cooking." Again:—"Convert the *dead* protoplasm into living protoplasm." There is no deliberate assertion here of any community of

property or chemical constitution of the dead and living matter; but, obviously for the purpose of carrying on the mind, and to enable the hearer or reader to follow the rapid description of the process of nutrition, the word protoplasm is used and qualified by adjectives, instead of a new and distinct term being employed. Dr. Beale would have had Professor Huxley substitute the expression "converted into various sorts of formed material" for the simple 'modified,' and for "dead protoplasm" he would require the insertion of a list of the chemical compounds, albuminoids, &c., obtainable from roasted mutton dissolved in the alimentary canal, and ready for absorption.

The method of drawing a conclusion exhibited in this paragraph from Dr. Beale (p. 286) is hardly admissible:—"Mr. Huxley says, 'all protoplasm is proteinaceous; or, as the white or albumen of an egg is one of the commonest examples of a nearly pure protein matter, we may say that all living matter is more or less albuminoid.' If the white of an egg is living matter, why should not its shell be so considered?" Now, surely no one will agree with Dr. Beale in imputing to Professor Huxley the assertion that 'the white of an egg is living matter.' Dr. Beale's logic runs thus:—1. All protoplasm is proteinaceous (Huxley); 2. White of egg is proteinaceous (Huxley); therefore, according to Huxley, 3. White of egg is protoplasm. This certainly is not what Professor Huxley concludes himself, but merely—therefore we may speak of protoplasm and white of egg as albuminoid, substituting this term for proteinaceous.

P. 287:—"He (Professor Huxley) also went so far (in 1853) as to remark that 'vitality is a property inherent in certain kinds of matter.'" This he has consistently—and there is no great virtue in consistency—continued to do in 1869, though Dr. Beale does not seem to think so. Such seems to me to be the very text of the Edinburgh lecture—understanding by vitality what is more simply called life.

The foregoing observations are made with the utmost deference to Dr. Beale. I have thought it right to reply to an interpretation of statements which, no doubt, is a genuine impression derived from the study of Professor Huxley's lecture, but which I, in common with many others, have not been led in any way to admit as a correct one.—E. Ray Lankester, B.A., Ch. Ch., Oxon.

Microscopical Societies in America.—The Academy of Natural Sciences of Philadelphia has organized a section to be called the Biological and Microscopical Department, which has been meeting now for more than a year, and has proved

exceedingly interesting. When we mention that S. Weir Mitchell and Joseph Leidy are active members of the Society, it is superfluous to add that valuable observations and discussions are recorded in the proceedings forwarded to us.

The State of Illinois, with that great appreciation of the value of true knowledge which characterises it, has inaugurated a Society to be called "the State Microscopical Society of Illinois." Our friends are not afraid of making, the State do for the individuals what they cannot so well do for themselves. We have to await such a disposition in Britain. We regret that we must refuse the invitation to a conversazione given by the State Society.

REVIEWS.

Les Annélides Chétopodes du Golfe de Naples. Par EDOUARD CLAPARÈDE. Geneva.
Observations Relatives à un ouvrage de M. Claparède. Par M. DE QUATREFAGES.

PROFESSOR CLAPARÈDE'S magnificent quarto volume, with its thirty-two beautifully drawn and coloured plates, has been expected anxiously by naturalists since the publication of the preliminary notice of the work by the author himself, which we gave in abstract some months since. That Annelids are truly microscopic animals in the sense that they cannot be at all studied without the microscope, no one can doubt who looks at M. Claparède's plates. The majority of the figures are illustrations of microscopic detail only to be observed with the highest powers, but necessary for the proper classification and identification of the beautiful creatures to which they belong, which are depicted beside them in true colours, as accurate as they are creditable to M. Claparède's artistic feeling.

We will not here go again over the ground which we have before traced, but allude to some of the matters of interest special to this volume. In the first place the work, which is the result of six months' observation during 1866–67, is dedicated to Armand de Quatrefages, Membre de l'Institut, in a few elegant phrases which state that M. Claparède intends to expose a great number of M. de Quatrefage's errors, but has a great feeling of regard for him and his labours.

M. de Quatrefages has felt not a little embarrassed by this dedication, and has failed to exhibit in his reply to some of the attacks that characteristic politeness and elegance, combined with severe critical power, which we notice in M. Claparède's work.

M. Claparède is not a Frenchman, although he writes some of his works in that language; and he has no sympathy with that curious and, indeed, altogether special, characteristic of French biologists, of omitting to refer to the works of previous writers on the subject they discuss—unless it be,

perhaps, a French name or two—and of thus advancing their own personality, and really falsifying the history of science. M. de Quatrefages has shown this tendency in his 'Histoire des Annelées,' and it is denounced by M. Claparède. We admit, with the critic, that the "falsification" is probably done unconsciously, or, we should say, carelessly, and is rather a national than an individual failing; and we must also observe that M. de Quatrefages has not been able to evade the charge in his reply; nor has he shown why he ignored the works of Rathke, Delle Chiaje, Grube, Kölliker, Leydig, &c.; nor again has he given, nor can he give any explanation of omission in the 'Histoire,' of any account of the segmental organs of Polychæta, many of which M. Claparède figures in the present volume. The advisability of constituting species of Annelids on ill-preserved museum specimens kept in spirits, is a subject which does not admit of much discussion, and M. de Quatrefages has very little to say in its defence. We objected to this and the absence of *figures* of new species in a notice of the 'Histoire' when it appeared.

The Gulf of Naples is a marvellously prolific source of Annelids, for in this volume species of nearly every genus occurring on our southern coasts, and a host of others, are described and figured.

One cannot speak too highly of M. Claparède's figures; they are drawn from life, and even the most highly magnified parts of the foot or head are rendered with a softness and grace which are to be found in few drawings but those of the Swiss professor. The author does not adopt the extensive generic subdivisions of Malmgren, nor does he appear to go even as far as Kinberg, retaining the genus Polynoë for the Lepidonoti, as well as the longer forms. His method of studying a species is more like that of Ehlers in his 'Borstenwurme,' than that of the Scandinavian systematists, accomplished though these latter observers are. Alciopina, a minute immature form, parasitic within a Cydippe, is one of the most novel forms described by the author. The magnificent species of Phyllochetopterus and Telepsavus, linking, as they obviously do, Chætopterus to Leucodore, and thence to Spio and Nerine, are exceedingly interesting types, and are illustrated with great detail. We cannot all at once pick out of such a book as this the new or important information it contains (additional to that given in the abstract some months since), for of nearly every species described something valuable is said, and anatomical and histological details of the utmost importance are given, witness the figures and accounts of the nervous system (differing in much from previous accounts) of

the bacillar-corpuscles, of the segment organs, of the true blood-corpuscles of the *vascular* fluid. It is rarely that one man contributes so much to the knowledge of a group (and so accurately, and trustworthily too) as Professor Claparède has here done. His work is not only a necessary guide to all engaged in the study of Annelids, but is a grand model of that excellence after which all naturalists should, however vainly, strive. Having a complete knowledge of the works of his contemporaries, he does not fail to give them their just due, whilst his great skill in observation and delineation enable him to correct their mistakes and to add new facts to the store of science. He does not permit his imagination to get the better of his reason, and his sound judgment does not allow him to misinterpret facts; lastly, he communicates the result of his researches in unaffected, pointed, and interesting language, which is quite free from the taint of egotism or pedantry.

QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE.

Histology. Blood.—W. S. Savory, in *Proc. Roy. Soc.*, April, 1869, gives reasons for believing that the nucleus in the *Red Corpuscles of Oviparous Vertebrata* is produced by post-mortem change, and is not present when the corpuscle is living. If blood be rapidly conveyed from a frog or reptile, and placed beneath the microscope, the corpuscles may be seen free from a nucleus which gradually makes its appearance by a segregation, as it were, of the coloured matter. In living Amphibia the corpuscles may be observed, according to Mr. Savory, quite devoid of nuclei.

Alexander Golubew describes, in Schultze's *Archiv*, vol. v, Part I, the structure of the *Walls of the Capillaries in the Frog*. He observes spindle-shaped bodies which, when stimulated, change their form, becoming thicker, so as to diminish the calibre of the capillary, even completely contracting it in some cases. His observations agree well with those of Lister, who attributed a contractile power to the capillaries, independent of nervous stimulus, in his researches on the frog.

On the Action of Salts of Quinine on the Movements of Protoplasm. C. Binz. *Archiv für Mikroskopische Anatomie*, Bd. iv, heft 3, 1868.—Dr. Bing asserts that weak solutions of sulphate of quinine have no influence on the changes in form which take place in the red corpuscles of the blood. On the other hand, this agent acts as a poison on Amœba and Actinophrys, and immediately arrests the amœboid movements of the white corpuscles of the blood.

Nerve.—*On the Terminal Apparatus of Nerves of Taste.* By Ludwig Letzerich. *Virchow's Archiv*, November, 1868.—This observer states that the nerves of taste in cats and oxen terminate in flattened vesicles, from which processes are sent inwards, and also outwards towards the upper surface of the mucous membrane of the tongue. These vesicles exist in the gustatory papillæ, and at the hinder part of the tongue, where the epithelial layer is thin, are placed

close to the surface. Their proper seat is the mucous layer, but they frequently project into the horny epithelial coat. The processes directed inwards from each vesicle are direct continuations of the nerves, the axis cylinders of which pass into the interior of the vesicle and there ramify. Each branch terminates in a prismatic body, which is placed on a short pedicle. The vesicle itself is filled with a colourless and slightly granular fluid, and its outer surface is marked with fine streaks, which, according to Letzerich, are suggestive of epithelial cells, and indicate the history of the development of the bodies. This probably consists in a fusion of several epithelial cells, in which the nerves are continued, and terminate in the manner described. The processes which pass outwards from the surface of each vesicle are lost in the horny epithelium.

On the Terminal Apparatus of Motor Nerves. W. Krause. *Archiv v. Reichert and du Bois-Reymond*, 1868. —A description is here given of the terminal enlargements of motor nerves. These bodies are elongated in the pike and in frogs, of an oval shape in chelonian reptiles, and rounded in other reptiles, and in birds and mammals. In the frog each primitive muscular bundle is furnished with a single terminal body, over which passes either one large nerve-fibre, or two or three short branches of one fibre. These nerve-fibres break up again into several small terminal branches, which are lost in the granulated and nucleated substance of the terminal body. Each of these minute branches bears a rounded terminal swelling. According to Krause, nearly the whole of the granular substance of the terminal bodies appears under the microscope to be made up of the finest terminal divisions of motor nerves.

On the Nerves of the Skin. P. Langerhaus. *Virchow's Archiv*, bd. xliv, 1868.—In this contribution a description is given of the ultimate ramifications and terminations of the nerve-fibres distributed to the superficial layers of the integument, and to the hair follicles and sudoriferous ducts. The following statements are given by Langerhaus as to the results of investigations made on sections of human integument treated by solutions of chloride of gold. The deeper parts of the dermis are traversed by ramifications formed by numerous small nerve-fibres without tendons, and in regions supplied with touch-bodies, as in the hands and feet, by several true doubly-contoured nerves. At the superior surface of the dermis these fibres pass into a very close rectilineal network made up of nerve filaments, which are extremely small, of a pale red colour, and freely nucleated. From this

network very minute fibres are given off, which pass through the rete Malpighii, and then along three or four rows of epithelial cells, and finally terminate in peculiar terminal corpuscles. Each of these bodies is ovoid, round, or oval in shape, of a light brown colour, and supplied with a nucleus. From the upper part of each corpuscle is given off two or more extremely minute filaments, which diverge and ramify among the epidermic cells, and finally end in small rounded swellings about half-way between the external surface of the epidermis and the rete Malpighii.

In the newly born child these corpuscles are very numerous, and are separated by intervals corresponding only to two, three, or six epidermic cells.

On the Nerves of the Cornea. By H. Petermöller. *Zeitschrift für Rationelle Medicin.* Henle u. Pfeufer, 1868.—In this contribution are given the details of the microscopic appearances of the nervous distribution in corneal tissue; the investigations were made on the corneæ of man, domesticated mammals, and birds, after the membrane had been subjected to the action of acetic acid and chloride of gold.

In man and the calf the nerve trunks which pass from the conjunctiva into the tissue of the cornea are soon broken up by dichotomous and trichotomous division into their primitive fibres. These fibres then lose their double contour, and by intercrossing with one another at right angles form a very fine network. There is no true anastomoses of the nerve-fibres, but a simple contact at the points where they intercross. Many of the larger fibres present distinct nuclei, the long axes of which are parallel to the direction taken by the fibres. In the cornea of the dog the nerve-fibres swell out at certain points, and here there is a true anastomosis. From these swellings, two, three, or more primitive fibres pass to other similar enlargements, and a rich network is thus formed. This network runs some distance below and parallel to the outer surface of the cornea. Above this, and placed more superficially is another nerve plexus, and the two are connected by fine varicose tubes and some ordinary nerve-fibres. The terminal branches of this superficial plexus pass to the very surface of the cornea. In birds there is a very distinct deep-seated plexus, which is formed in the following manner:—two or more primitive nerve-fibres, after losing their double-contour, run parallel for a certain distance, and then terminate in a large oval granular body, from which one or more fibres are given off to form a fine plexus.

Petermöller has never found any direct continuation of the nerve-fibres into the substance of the corpuscles of the cornea

The presence of a network of nerve-fibres has been observed in all domestic mammals, with the exception of the pig.

Professor Pflüger, of Bonn, has two important papers in Schultze's *Archiv*, v, Part 2, on the *Ending of Nerves in the Salivary and Pancreatic Gland.* He figures an abrupt termination of the nerve tissue amongst a group of gland-cells, with the substance of which he believes the nerve to be continuous. Hyperosmic acid has been used to bring out this relation. Pflüger calls this method of termination "Protoplasmafüsse." This matter, at which Pflüger has worked for some time, and published more than three years since, should be examined into by some English microscopists. Franz Boll, a student at Bonn, confirms Pflüger's views in a paper translated in this Journal, vol. vii, p. 262. Professor Pflüger here adds some very interesting observations on the development of the epithelium of the gland, tracing its relation in origin to the nerve.

Muscle.—C. L. Heppner describes in Schultze's *Archiv*, v, Part 1, a *Peculiar Optical Appearance in Striped Muscular Fibre*, which is neither more nor less than the dark line intervening in the light space between two dark spaces of the fibre described long since by Sharpey, and figured in Quain and Sharpey's 'Anatomy, 7th edit., 1867, vol. i, p. 118.

Dr. Schwalbe has in Schultze's *Archiv*, v, Part 2, a very interesting comparative study of the *Finer Structure of the Muscle Fibres of the Invertebrata*, illustrated by two plates. The comparative histology of muscular tissue is well worth prosecuting still further. Some very careful drawings of muscle fibres in Echinoderms, Cœlenterata, Annelida, Gephyrea, and Mollusca are given.[1]

On the Structure of Smooth Muscular Fibre. — G. Schwalbe, in Max Schultze's *Archiv*, band iv, heft 4, gives the results of investigations made into the structure of unstriped muscle taken from the dog's bladder. The fibres, after a prolonged action of a weak solution of chromic acid, could be readily isolated. The three chief elements of these fibres were: one or two nuclei, each containing one or two nucleoli; a small quantity of protoplasm; and contractile substance. This article concludes with some remarks upon the shape of unstriped muscular fibres. It may be readily observed, on transverse section of involuntary muscle, that the uninjured fibre-cells are generally round, or of an irregular spindle shape. After isolation, however, fibres are often

[1] The cellular muscular fibres figured in my paper on "Chætogaster," herein, and similar fibres in low Crustacea observed by Dr. Van Beneden, are worthy of mention in connection with this subject.—E. R. L.

found which present themselves as flattened bands, pointed at the ends, and with the nucleus either entirely absent, or lying detached near the outer surface. Closer examination will reveal transition forms between the round and the flattened cells, as many may be observed which appear round towards one extremity and ribbon-shaped towards the other. A drawing is given of a fibre-cell the lower part of which is pale and flattened, whilst the upper part of the same is round, and marked with several colours. Between these two parts is a sharply-defined linear slit, which at the commencement of the round part of the fibre is bifurcated. The lateral portions of the fibre on each side of this slit become thinner as they pass into the lower or flattened portion. The ribbon-like form of one part of the fibre no doubt results from the change in position and shape of the lateral portions divided by the slit, which extends to the centre. The nucleus during these changes becomes detached from the muscular fibre, and is either altogether removed, or rests upon the surface. This superficial position of the nucleus is not the normal condition in the smooth muscular fibre of the bladder, as one may in transverse sections of fresh and uninjured muscle always readily observe one or two nuclei in the central part of each cell.

Shell.—Professor King, of Galway, who has much right to speak with authority on the subject he discusses, treats of the *Histology of the Test of the Class Palliobranchiata*, in the *Trans. Royal Irish Acad.*, vol. xxiv, 1869. He figures the perforations in many genera, and has some especially valuable remarks on *Crania* and *Megerlia*. He maintains that *Syringothrysis cuspidata* is not represented in an isomorphic genus, as maintained by Dr. Carpenter, on account of the supposed absence of perforations in a specimen called *Spirifer cuspidatus*, which was submitted to him for examination by Mr. Davidson.

Professor Percival Wright, of Dublin, describes *the Structure of Tubipora musica* (the Organ-pipe Coral) in the *Annals* for May. He was successful in obtaining this polyp alive in his recent visit to the Seychelles. He describes the tube as formed by the agglomeration of fusiform and nodular spicules, which increase as growth proceeds, thus differing from Kölliker, who assigns a crystalline structure to the tube of Tubipora.

Microzoology.—*The Anatomy of Stentor and its Mode of Reproduction* is described by Dr. Moxon in the *Journal of Anatomy*, May, 1869. He particularly opposes the view that the "contractile vesicle" of Infusoria forms part of a

circulating system; and maintains, 1st, that there is no need of finely ramifying vessels in organisms so minute as Infusoria; 2nd, that they have not been seen, their supposed indication being due to pressure, &c.; and 3rd, that the vesicle clearly opens by an external orifice in *Spirostomum* and *Stentor*. Dr. Moxon also shows that the "lateral crest" of Stentor is part of a newly budding individual. He does not appear to be acquainted with a valuable paper by Dr. Zenker (Schultze's 'Archiv,' ii, p. 332, and 'Quart. Jour. Microsc. Science,' vol. vii, p. 263), in which the question of the function of the vesicle is discussed, and it is very clearly shown to open outwardly. Dr. Zenker had observed the vesicle of *Spirostomum* previously to Dr. Moxon. He says:—"After seeing this animal, it is incredible that the existence of an external orifice should have been so long a matter of doubt."

Professor Wrzesniowski, of Warsaw, publishes a valuable study on the *Anatomy of the Infusoria* in Max Schultze's *Archiv*, v, Part 1 (1869). He figures and describes the vesicle, the anus, the nucleus, and the trichocysts of several large species of Infusor. He regards the vesicle as excretory.

Australian Polyzoa is the title of a paper by P. H. MacGillivray, A.M., M.R.C.S., read before the Royal Society of Victoria. Forty-eight new species are described, and two new genera. Figures are not given in the present publication, but are promised in Professor M'Coy's forthcoming 'Memoirs of the Museum.' Specimens are deposited in the National Museum of Victoria. The new genera are Dictyopora, belonging to the Escharidæ and Petralia of the same family.

On the Developmental History and Systematic Position of the Bryozoa and Gephyrea is an important paper by A. Schneider, in Schultze's *Archiv*, v, Part 2. Very new and startling views as to the relations of the two groups above-named are put forward, which demand the fullest consideration, coming, as they do, from so eminent an observer as Anton Schneider. We have not space now to reproduce Schneider's views, but the paper *must* be read by all who are interested in philosophical zoology.

On the Dimorphism of the Ovary in Tubifex.—Dr. Fritz Ratzel, of Carlsrhue, in an article on the *Anatomy and Systematic Arrangement of the Oligochæta* (Kolliker's and Siebold's *Zeitschrift*, heft iv, b. 18), states that in Tubifex rivulorum the ovary presents itself in one or other of two different forms. The first and more frequent form is that

which, up to the present time, has generally been described as always existing in the species. This consists in a pair of pyriform organs, which are placed together in the eleventh segment of the creature. Each is enclosed within a special membrane. The ova are arranged from above downwards, on one side of each ovary, in such a manner that the largest, that is, the ripest, are placed at the lower part, whilst the less mature ascend one above the other as far as the apex of each organ. The regular gradation in the size of the ova gives to the ovaries a characteristic appearance. The ripe ova are discharged through a rupture in the enclosing membrane. Besides this, stated by Ratzel to be the principal form, another condition has been found in which the ovaries resemble those existing in Enchytræus. This state of things has during a course of observations on 150 specimens of Tubifex been found in one out of every twelve. The ovaries are placed in the eleventh segment, on each side of the intestine, like those in the Tubifex, but are here broken up into a number of globular masses averaging in size from 0·6 to 0·8 mm., which lie side by side in the general cavity of the body, and are not contained within any special membrane. These masses, which float about the general cavity, are really groups of ova, and each generally contains one large and ripe ovum. As this is the normal form of ovary in Enchytræus, Ratzel applies to a similar construction in occasional specimens of Tubifex the name of the second, or Enchytræus form. In endeavouring to account for the remarkable phenomenon of the occasional appearance in tubifex of a form of ovary found constantly in another species, Ratzel cannot accept the view that it is owing to some pathological change. To this are opposed the facts of the perfectly normal condition of the rest of the organization in such cases, the perfect resemblance of all the ovaries thus formed, and the number of individuals found with these organs in this condition. Ratzel did not find a single instance of the Enchytræus form of ovary in an examination of over a hundred specimens of Limnodrilus, a worm closely allied to Tubifex. He is inclined to look upon this phenomenon as an instance of atavism and reversion in structure, and believes that though Tubifex and Enchytræus stand far apart in the group of the Oligochæta, the species are yet so closely allied as to render reversion a possible occurrence.

Cysticercus Lumbriculi. Dr. Fritz Ratzel, *Archiv für Naturgeschichte*, heft 2, 1868.—According to Dr. Ratzel many specimens of Lumbriculus variegatus have been found infested at all seasons of the year by a parasitic creature,

to which has been given the name of Cysticercus lumbriculi. The seat of this parasite is the general cavity of the host's body, between the intestine and the integument, along all the segments. There is generally but one of these parasites, but in exceptional instances several may exist in one host. As many as eight have been found by Dr. Ratzel in one Lumbriculus. The body of Cysticercus lumbriculi is round, and of an average diameter of 0·42 mm. Its outer membrane consists of a vesicle, the tissue of which is made up of soft cells, with no external membrane, and containing granular nuclei. Among these cells are scattered a few fat-globules and some muscular fibres. Within this is a second membrane, which is a resisting chitinous capsule, perforated at the upper and lower parts by two openings. Near these openings the wall of the capsule is thickened, and at the lower one there is a tending inwards of the external vesicle, and a union of this with the margins of the internal chitinous capsule. At this point the head of the parasite is developed, and subsequently a short wide neck, in which are disposed numerous calcareous bodies. The head carries a rostellum, a circlet of ten hooks, and at an advanced stage sucking discs. Between the external vesicle and the internal chitinous one is an interspace which is filled with a transparent fluid.

Dr. Ratzel thinks it very probable that this Cysticercus may become developed into a Tænia, infesting birds, and particularly birds which frequent marshes, as it has been found only in Lumbriculi which live in marshy places, and never in those taken from flowing water and localities not of a marshy character.

On the Reproductive State of Saprolegnia monoica is the title of a paper by Johannes Reinke, in Schultze's *Archiv*, v, Part 2.

Microphytology.—*Notes on Diatomaceæ from Danish Greenland, collected by Mr. Robert Brown.* By Professor Dickie, Botanical Society of Edinburgh. No. I.—All the species recorded were British, with the single exception of *Hyalodiscus subtilis*, originally described by the late Professor Bailey, from Halifax; found also on the shores of North-West America, and now on the shores of Greenland.

On the Diatomaceous Frustule. By John Denis Macdonald, F.R.S. *Annals and Mag. Nat. History*, Jan., 1869.—Dr. Macdonald observes that Dr. Wallich was the first to put forward a part of the views which he expresses in this paper, and to show that the "membrane" between the two valves consists of a hoop enclosing a second hoop, so that one

valve with its hoop is partially embraced by, or let into, the hoop of the other valve. One valve and hoop has of course been produced by division from the other valve, and to this latter the name of primary valve was given, whilst the other was called secondary. Dr. Macdonald illustrates in the case of Biddulphia the formation of the new valve and hoop, one within each of the old pair, their growth and separation; and he points out that the new valves must be ever smaller and smaller. How then is the size of the species maintained? An answer is found in Thwaites' observation, the author remarks, who noticed that the sporangial frustrule was so much larger than the parent, and whose observation was misinterpreted by Smith in the other direction, viz., that the parents were very much larger than the sporangial product.

The Genus Lophiostoma.—A descriptive synopsis of the twelve British species of Lophiostoma (Fungi) by M. C. Cooke is published in the 'Transactions' of the Botanical Society of Edinburgh for 1868, just issued to the fellows. It is accompanied by a coloured plate of the asci and spores of the majority of species, magnified from 300 to 400 diameters.

Greenland Diatoms.—Dr. Dickie has examined the Algæ collected in Greenland by Mr. Robert Brown, and enumerates the following:

Epithemia ocellata, *Kütz.*
Eunotia monodon, *Ehr.*
Synedra ulna, *Ehr.*
Navicula dicephala, *Kütz.*
Stauroneis anceps, *Ehr.*
Stauroneis gracilis, *Ehr.*
Cocconema lanceolatum, *Ehr.*
Meridion circulare, *Ag.*
Odontidium mesodon, *Kütz.*
Tabellaria flocculosa, *Kütz.*
Himantidium majus, *Sm.*
Arachnoidiscus Ehrenbergii.
Actinocyclus undulatus.
Biddulphia Roperiana.
Cocconeis scutellum.
Cocconeis Grevillei.
„ undulata?
Podosphenia Ehrenbergii.
„ gracilis.
Podosira hormoides.
Rhabdonema arcuatum.
„ minutum.
Synedra affinis.
„ investiens.
Nitszchia „
Triceratium arcticum.
Coscinodiscus eccentricus.
Grammatophora marina.
Isthmia nervosa.

The few species noted here are to be considered as supplementary to Dr. Lyall's Diatomaceæ recorded by Mr. Kitton in the ninth volume of the 'Journal of the Linnean Society.'—*Trans. Bot. Soc. Edinb.*, 1868.

PROCEEDINGS OF SOCIETIES.

Dublin Microscopical Club.

21st January, 1869.

Dr. E. Perceval Wright exhibited a species of Corticate Sponge, from the collection made by him in the Seychelles, from the peculiar structure of which he was inclined to believe that it should be referred to Bowerbank's genus Pachymatisma, of which only one species was known, *Pachymatisma Johnstonia* = *Amphitrema M'Callii*, Scouler, MSS. The oscula in the Seychelles species were few in number and simple, pores inconspicuous. The oval siliceous bodies in the corticate layer were as in Pachymatisma; but some few appeared to have a dark central nucleus; the interstitial spicules were cylindrical and also "cylindro-patento-ternate;" sarcode spicules stellate.

Mr. Archer drew attention to a Heliozoan Rhizopod, being the same he exhibited at the Club meeting, 19th September, 1867, and which he had little doubt was the same as the first of the forms figured and expatiated on by Dr. Focke in Siebold and Kölliker's 'Zeitschrift für Wissenschaftliche Zoologie,' Bd. xviii, Heft iii, p. 345, t. xxv, which had just reached his hands, and which he now exhibited. He would, however, defer any further enlargement upon it for the present, until he had an opportunity to bring forward another closely allied form, which two together, he thought, excellently represented a new and distinct genus. The essential character of this genus would be that the central body, bearing long slender pseudopodia, is enclosed within a stratum of a quite different looking sarcode, itself giving off pseudopodial processes of its own, different in character from those emanating from the central body. This genus, which he would call Heterophrys, and the present form *Heterophrys Fockii*, he hoped to figure and describe on a future occasion.

Rev. E. O'Meara showed a peculiar Diatom taken from the stomach of an Ascidian from Belfast Lough. It presented the general appearance of *Nitzschia bilobata*, but the surface of the valve between the striate border and the margin of the hoop was covered with wart-like excrescences irregularly disposed. Five or six examples were found in the gathering, all presenting the same peculiar feature. He considered it a variety of *Nitzschia biblobata*, and suggested for it the distinctive name of *verrucosa*.

Dr. Moore exhibited examples of the Prothallia of Ferns, showing the archegonia; he explained the morphological structure

of this remarkable type of reproduction, and enlarged on the physiological questions involved.

Dr. Traquair showed a series of Foraminiferous Shells from Dog Bay, Connemara.

Dr. John Barker drew attention to a circumstance, seemingly generally overlooked (now exemplified by the motions of *Urocentrum turbo*), connected with various animalcules, both rotatoria and infusoria. What he alluded to was their having the appearance during motion as if influenced or confined, or even moored, by some invisible thread or tether to foreign bodies. The animalcule spins and rotates, the while describing an arc of a circle, backwards and forwards, at an even distance from an apparent point of attachment; nay, if the foreign body, seemingly forming the centre round which the animalcule hovers, be but of moderate volume or weight, it may be drawn along as if pulled by the supposed thread—supposed, indeed, because it must be admitted that it is never visible. After a little the motions of the creature may become more vigorous, and *seemingly* the *cord* snaps, for suddenly the animalcule darts off in an onward direction. This kind of appearance would seem sufficiently common in different forms as apparently to contradict the idea that it may be only a characteristic fidgety motion of any particular form, and even to lead to the idea that many minute forms actually have a power of spinning or paying out an immeasurably delicate cord of attachment, so delicate as to evade all means we possess of seeing it, and one which it can itself sever at will.

18*th February*, 1869.

Dr. E. Perceval Wright exhibited preparations of an Alcyonoid from Messina and Syracuse, which had been described some years ago (1842) by Philippi as *Bebryce mollis*. Milne-Edwards, in his 'Histoire des Coralliaires,' rejects both the genus and species, stating on the authority of Valenciennes that it was described from nothing more or less than the stalk of an ordinary Gorgonian, on which a colony of *Sympodium coralloides* had established itself. Kölliker, however, in his 'Icones histiologicæ,' mentions that he had an opportunity of examining the very specimens described by Philippi, and explains that the figure illustrating his paper in the 'Archiv für Naturgeschicte' represents the polyp with "retracted" tentacles, whereas the description laid emphasis on their being non-retractile, and that from this discrepancy arose the want of belief in the genus. The specimens now exhibited were dredged in the Gulf of Messina in June of last year, and resembled in every respect the species figured by Philippi; they were recognised as this species by Dr. J. E. Gray the moment he saw them. They agree, moreover, with Philippi's description, omitting the word "not" before retractile, when describing the polyp, so that Dr. Wright thought that, without doubt, his species, though not compared with the original type-specimens, now

in Prof. Leuckart's Museum, was really *Bebryce mollis* (Phil.). Here it may be remarked that the Messina specimens were in good condition and preserved in spirit. Kölliker, in his description of the cœnenchyma of this species, says that the calcareous spicules are all scale-shaped, and that these are more or less toothed; that they vary in outline, the extremes being—(1) large scales, with small middle outgrowths; and (2) small scales, with large outgrowths or excrescences. Those seen in profile mostly appear of a "nine-pin" shape, with clipped ends; all these spicules are "twins," and in most the line of separation is clearly discernible. These various forms of spicules were exhibited. The "scale" spicules, large and small, of all manner of irregularity of outline, were found, forming an outer crust to the ectoderm; but, in addition, there was found another form of spicule found by Kölliker occurring in Eunicea, which did not appear to be a "twin" form of spicule, and which seemed to be very distinct from any of the forms called scale-forms by Kölliker. These spicules appeared to occupy the inner portion of the cœnenchyma, and especially that portion of the base of the polyps; they have been referred to by Kölliker as the "Blattkeulen," but this name he applies also to spicules of a very different shape; perhaps the name "shuttlecock" spicule may be found to be more appropriate.

Mr. Archer exhibited another new form of Heliozoan Rhizopod, of a type similar to that shown by him at last meeting, believed to be identical with that spoken of, but not described, by Focke (Siebold and Kölliker's 'Zeitschrift für wiss. Zoologie,' Bd. xviii, Heft iii, page 345, t. xxv), that is, the present forming a second species in the genus Heterophrys (Arch.). It was to be regretted that he had not been able to meet with a specimen of the form shown on the last occasion, for the sake of contrast with the new form now drawn attention to; and it was still further to be regretted that the example of the latter now presenting itself had suffered much (upon the slide) in the transit down to the meeting; and as he had spent hours in searching for the only one he had met with for this occasion, he was afraid it would be fruitless delay at the meeting to try to search in the material for another specimen. But crushed and somewhat crowded upon by other objects as the example shown might be, he was very glad to be so fortunate as to have been able to get it, as the specimens were greatly diminishing in the material; he trusted, however, the various points to which he would wish to draw attention could be made apparent. The present was a good deal larger form than Focke's, the central sarcode mass hyaline, but densely loaded with chlorophyll-granules, and possessing a few smaller, darkish granules; pseudopodia emanating therefrom long, filiform, but *comparatively* not very slender; outer stratum cloudy and granular, and at the periphery divided into an innumerable quantity of slender hair-like processes. He would name this fine form *Heterophrys my-*

riopoda, and hoped to give a figure and description of it ere long in the 'Microscopical Journal.'

Mr. Archer further presented examples of another, not less remarkable, Freshwater Rhizopod. This large and fine form was loosely coated with foreign heterogeneous particles, and differed from every other form by presenting two characters of pseudopodia, emanating from different portions of one and the same sarcode body. The general form is egg-shaped, covered loosely by an aggregation of foreign arenaceous particles, diatomaceous fragments and frustules, seemingly dead protococcoid structures, and bits of fibrous-looking matter, earthy-looking particles, &c. From the anterior end projects an almost hemispherical elevation, whence emanates a dense cluster of variable, often inordinately long, hyaline, branched pseudopodia; and from the general surface of the body elsewhere, and projecting through the outer loosely aggregated covering, there proceeds a dense quantity (looking at the margin like a fringe) of hyaline, short pseudopodia, nearly uniform in appearance, thickness, and length. The frontal eminence showed a marginal pulsating vacuole, like Actinophrys, and the central mass a large "nucleus." This could not at all be considered, even apart from the border of nearly equal short processes, as like a Gromia—that is, such as the typical *Gromia fluviatilis*, though it may have some closer affinity to the form called *Gromia Dujardinii* by Schultze; that form, however, appears pretty clearly cannot be correctly regarded as a Gromia at all. Mr. Archer felt sure that those who had seen a living Gromia must acknowledge the great difference in character of the pseudopodia, apart from the test being membranous in that genus, and the presence of the fringe-like border of processes in this form. In character of pseudopodia there is more resemblance to certain forms, possibly referable to Pleurophrys (Clap. et Lachm.), which Mr. Archer showed, but which he had doubtfully ere now imagined may have been (some one of them) the type of Schlumberger's Pseudodifflugia. Mr. Archer intended ere long to publish a figure of this fine form as the type of a distinct genus, which he named Diaphoropodon.

Mr. Archer exhibited, on the part of Mr. Walter W. Reeves, of London, some specimens, kindly forwarded by that gentleman, of a form of Cothurnia from Victoria Docks, London, which appeared to be new and strikingly characterised by the possession of a closely fitting operculum attached to the neck portion of the animal, and by which, upon withdrawal into its case, it could securely close the mouth of the latter as with an accurately adapted lid. It was likewise characterised by an exceedingly long and slender stipes. This remarkably beautiful object, which Mr. Reeves informed Mr. Archer would immediately be figured and described by Mr. Kent, was accompanied by numerous other elegant things—forms of Carchesium, Acineta, various rotatoria, &c., and amongst these a conspicuous Vaginicola, with a campanulate case, in several examples of which could be readily seen

a valvular structure, raised and lowered by the motions of the animal in and out of its case, just as in the cylindrical form called *Vaginicola valvata*.

A vote of thanks was passed to Mr. Reeves for the opportunity to see this new and beautiful specimen.

18*th March*, 1869.

Mr. Archer showed a new and minute freshwater Rhizopod referable to Dujardin's genus Gromia. This rather inert-looking form at first called to mind somewhat the appearance of a Chytridium, but their occurrence not attached to any foreign body and a further observation showed their true nature. The test is very minute, orbicular, hyaline, smooth; body within the test opaque, bluish, granular, with an eccentric whitish nucleus, each with a central dark nucleolus; pseudopodia often long, slender, hyaline, bearing in a slow circulation several darkish granules, often cohering by the pseudopodia one to the other in small groups. Mr. Archer hoped to shortly give a figure of this curious little form, with a description, and would meantime call this form *Gromia socialis*.

Dr. E. Perceval Wright exhibited a section of a series of spicules belonging to a Creeping Sponge, met with by him at Mahè, which had been described by Dr. J. E. Gray as *Placospongia melobesioides*. He thought that though this genus was certainly closely allied to Geodia, yet that perhaps, until we knew more of the generic peculiarities of the Corticata, the genus may be retained. He brought it forward now chiefly in continuation of a series of notes already before the club on the "Sponges of the Corticate Division" of Oscar Schmidt. Dr. Bowerbank thinks that this species is the same as his *Geodia carinata* ('British Sponges,' vol. i, p. 239), but this does not appear to be the case. Duchassaing and Michelotti have described a genus called *Acamas;* one species (*A. violacea*) appeared to come very closely indeed to *Placospongia melobesioides*.

Dr. John Barker showed a new Compressorium constructed by Mr. Ross, having the advantage of readily exerting a *direct* vertical pressure on the object, the extent of which is regulated by turning a screw placed at the left hand of the platform, which was made to receive an ordinary slide and cover, thus presenting the very valuable facility of being able to submit any object casually encountered without any difficulty to the action of the compressor. Dr. Barker, however, was about to suggest to Mr. Ross some modifications which would still further facilitate the use of this little instrument, so as to retain the slide at the most convenient place before the screw pressure became exerted.

Dr. Moore showed the Spores of *Hypnum stramineum* in various stages of germination. In those farthest advanced the confervoid-like threads, as they issued from the spore, spread themseves over the surface of the leaf itself, which, being transparent, afforded a

good opportunity of seeing that those filamentous substances form immediately on the contents of the spore dissolving, each spore giving birth to a number of them. In some cases the contents appeared to be composed of elongated particles while *in sitû*, before they issued from the spore. The question arose as to whether each of the filamentous threads, under favorable circumstances, was capable of ultimately giving rise to a new plant, or whether a number of them coalesced to form one—which was left undecided until further observations are made.

Mr. Crowe exhibited a section of flint, having not only the usual so-called Xanthidia imbedded in it, but likewise showing in section a fragment of some coniferous wood, with its characteristic pits.

Rev. E. O'Meara showed his original drawings of sundry new Diatoms, and gave their characters and distinctions. These were named *Pleurosigma giganteum*, var. *baccatum*, *Plagiogramma costatum*, *Melosira Wrightii*, *Pinnularia marginata*, *P. scutellum*, *Amphiprora costata*, and were to appear in next number of the 'Microscopical Journal.'

Dr. Moss, R.N., exhibited a series of sketches from nature of Mediterranean and Atlantic forms of Appendicularia, and of the enigmatical "Haus of Merten's," in which they were often found enclosed. He remarked that this curious structure seemed to be associated exclusively with the oval-bodied or thoracic Appendicularia, of which *A. flagellum* might, perhaps, be regarded as a type. In two specimens of *A. furcata* captured near the Azores in February, 1869, an organism resembling in form the oval-bodied Appendicularia, and appearing from its motion, attachment, &c., to be embryonic, was found on the right neural portion of the upper part of the branchial cavity, a short distance below the base of the lowest of six oral tentacula, in very much the same situation in which Gegenbaur described and figured an unsymmetrical ciliated orifice. Observations calculated to throw light upon a subject so obscure as the reproduction of these animals must necessarily be advanced with caution, but there are grounds for the hope that ere long we will be as well acquainted with the Appendicularia as with their pelagic brethren, the Salpas and Pyrosomas.

Mr. Woodworth exhibited a series of excellent photographs of various microscopic objects, which he presented to the Club.

Mr. Tichborne exhibited a slide of Sulphate of Copper, crystallized at 75° Fahr. This formed a beautiful polariscope object of a peculiar form. This salt, which has a normal composition of $CuSO_4$, $5H_2O$, loses part of its water of hydration at elevated temperatures, and crystallizes in a form quite distinct from the ordinary one.

Mr. Archer drew attention to some examples of a very minute organism which he had detected in several gatherings lately, and which he must, he thought, have hitherto overlooked, for he now found it not very uncommon; it was, however, one which as yet

baffled attempts to refer to any particular type. It formed a very minute globular body, semi-pellucid, and of a bluish hue, having immersed therein an amber-coloured globule mostly of considerable brilliancy, and occupying a large proportion of the mass of the little sphere. The whole was surrounded by a thick covering, loosely and irregularly clustered around it, of a heterogeneous variety of fragments and shreds of other organic bodies, such as splinters of diatoms, bits of protococcoids and confervoids, and various fibrous-looking elements. There were occasionally two, and Mr. Archer had once seen three, of these globular bodies so surrounded by this outer cluster of foreign fragments, which mostly assumed an elliptic but irregularly margined general outline round the globular central body. There was an appreciable interval between the latter and the outer cluster. Now, this description of the central body, apart from its surroundings, would call to mind (as undoubtedly the examples themselves did) much of the appearance of Dr. Barker's rhizopod, *Diplophrys Archeri* (see "Dublin Microscopical Club Minutes," 19th Dec., 1867). But Mr. Archer had looked in vain over many specimens of the organism now exhibited for any indication of pseudopodia, nor, indeed, did any kind of locomotive organ present itself. Still, if one could imagine Diplophrys, not only with its pseudopodia fully retracted, in which condition it is sometimes met with, but also loosely surrounded in some manner by an aggregation of minute and heterogeneous fragments, it is quite true we should have an object not distinguishable from that now drawn attention to by Mr. Archer. There was nothing further, however, to prove that this was a state of Diplophrys, which is rare, and never met with in the numbers in which these were present. It would seem clear, however, that this must, some time or other, have a non-quiescent state, in which it must be able, in travelling, to discover and *select* the various fragments, loosely assorted, within which it ensconces, though does not hide, itself, for the pellucid character of the *débris* employed enables one readily to see the globular body inside, with its amber spot, often looking under a peculiar illumination and focus like a bright flame within. Thus, whilst unable to form any accurate idea as to the true nature of this curious little production, Mr. Archer thought that even its present total inexplicability would lend it a certain amount of interest.

Royal Microscopical Society.

April 14th, 1869.

The President (the Rev. J. B. Reade) in the chair.

A paper on "Protoplasm and Living Matter" was read by Dr. Lionel Beale. We have commented on this in another part of the Journal. A discussion followed, in which the question of vitality

was largely talked of by the Fellows of the Society. Dr. Wallich asserted that he had found deposits in gutters, and in the outlet of the metropolitan main sewer at Crossness, having the characteristics of Bathybius.[1] The President said that Dr. Beale's paper reminded him of a remark made by Dr. Milner, when asked if he could refute Bishop Berkeley's theory of matter. He replied, "I cannot answer it. It contradicts common sense, and there must be great nonsense *somewhere*." He could not say where, however.

May 12th, 1869.

The PRESIDENT in the chair.

Mr. George Busk sent in his resignation as a Fellow of the Society, and was elected an Honorary Fellow on the motion of the President.

Mr. B. T. Lowne read a paper on "The Rectal Papillæ of the Blow-fly," and Mr. Suffolk made observations on the proboscis of the same insect, and exhibited drawings of it.

The President described an addition to his kettle-drum condenser, consisting of a third lens.

June 9th, 1869.

The PRESIDENT (Rev. J. B. Reade) in the chair.

The President described a most valuable new form of illumination, which he declared had rendered the microscope a new instrument to him. He had by its means been able definitely to settle the structural cause of the markings of the diatom valve, which he could now demonstrate most clearly, even with a $\frac{2}{3}$, as spherical nodules arranged in lines. A young friend of his, looking at a specimen with this new method of illumination, had exclaimed, "It is just like a dish of marbles." The illumination which was so successful was obtained by means of a prism whose section is an equilateral triangle; by its use parallel direct rays are thrown, which avoids the unnatural and deceptive complications obtained by the use of converging rays.

Mr. Wenham remarked that he had shown, by observing the form of splinters of fractured diatom valves, that the markings on the surface were really due to hemispherical projections. A paper by him on this subject was published some years since in the 'Quarterly Journal of Microscopical Science.'

Mr. Eulenstein, the author of the 'Series of Diatoms,' remarked that he had, by the most careful study of very many species, come to the conclusion that there were two forms of marking in diatoms—first, by the framework, consisting of ridges and elevations characteristic of genera; and secondly, by the universal

[1] Has Dr. Wallich ever compared the two appearances, or on what ground does he venture this statement?—E. R. L.

spheroidal tubercles, which were more or less thickly disposed on all diatom valves.

Dr. Eulenstein took the opportunity of mentioning that he had purchased the late Dr. Arnott's tubes of diatom material, and was prepared to issue series of the species in this collection (the most complete British collection) on application.

Mr. Beck called attention to the fact that his brother, the late Richard Beck, had urged the probability of the spherical character of the diatom markings, and had shown by photographs of a piece of glass marked with hemispherical protuberances how an hexagonal or dotted appearance could be obtained by varying the illumination.

Mr. Jabez Hogg read a paper entitled "Results of Spectrum Analysis," in which he gave some of Mr. Sorby's observations, published more than a year since in the Royal Society's proceedings, and also exhibited a drawing of chlorophyll spectra, by the late Dr. Herapath.

Mr. Ray Lankester expressed his disappointment at the incompleteness and inaccuracy of Mr. Hogg's paper. He pointed out several fallacies and mistakes in Mr. Hogg's statements, such as the asserted presence of hæmoglobin in the blood of the house-fly, in which animal its presence is really due to its having been taken in as food, and is met with only in the alimentary tract; the asserted discovery of copper in turacin by the spectroscope, which was a complete misrepresentation, since Professor Church had discovered the copper before the absorption bands; and the supposed connection of thallium and chlorophyll, which Mr. Hogg had ventured to suggest. Mr. Lankester pointed out that Mr. Hogg had omitted all reference to the really valuable physiological results obtained by examining the action of gases on the blood with the spectroscope, and had also not mentioned its use in detecting hæmoglobin and chlorophyll in the lower animals, which he (Mr. Lankester) had written upon. Mr. Hogg had pretended that sodium could be recognised in increased quantity in a cataract-lens by means of the spectroscope. This Mr. Lankester entirely denied.

MEMOIRS.

Monograph *of* Monera. By Ernst Häckel.

(*Concluded from page* 232.)

While on the one hand the kingdom of the Protista is increased by the Labyrinthulea with a separate class, on the other hand it may now be satisfactorily proved that another group of Protista should be removed from this kingdom, and referred to the animal kingdom as decided animals. These are the Sponges, of whose animal nature very decided morphological indications have been very recently discovered. As long ago as 1854, Leuckart, the illustrious founder of the sub-kingdom Cœlenterata, in his yearly report upon the progress of zoology (in the 'Archiv für Naturgeschichte'), united the sponges or Poriphera with the Cœlenterata, by a comparison of the canal system of the sponges with the cœlenteric gastrovascular apparatus of the true Cœlenterata.

Last winter, my pupil and assistant, Herr Miklucho-Maclay, of St. Petersburg, during our stay at the Canary island Lanzarote, examined carefully the exceedingly rich sponge-fauna of these coasts, and, as I have convinced myself by ocular inspection, thereby discovered new forms of sponges whose anatomy furnishes far stronger proofs of the near relationship of the sponges with the Cœlenterata than we hitherto possessed. For instance, Herr Miklucho has discovered a calcareous sponge (*Guancha blanca*) nearly allied to *Sycon* and *Ute*, but whose entire interior system consists of a simple cylindrical stomach, a digestive cavity, as in the simplest Hydroida. The so-called oscula (Camini) of the sponges are not only excretory openings, as they have hitherto been considered, but also serve for the reception of water and food. These external openings are at once mouth and anus. In a word, the oscula are the stomachic cavities of the Cœlenterata, analogous to those of the polypi, and in all probability homologous with them at the same time. The canals proceeding from the oscula correspond with the canals which ramify in the parenchyma of many Anthozoa. But what

seems to me of the greatest importance is that this stomachic cavity is divided in several sponges (*Axinella* and others) by radial partition walls into compartments (of various or constant number, especially eight!), and thus the entire body of the individual sponge seems to be composed of a fixed number of antimera. I had hitherto always considered the absence of antimera-formation as one of the most important morphological differences between Sponges and Cœlenterata. By their similar mode of propagation, &c., the near relationship of the sponges and Anthozoa becomes still more probable. In short, I now consider it most correct to follow Leuckart's example in uniting the Sponges with the Cœlenterata systematically, and therefore consider it very probable that both groups have had a common origin. The phylum of the Cœlenterata would henceforth divide into two subphyla. I. Spongiæ (Cœlenterata without urticating organs): 1. Petrospongiæ; 2. Autospongiæ. II. Acalephæ[1] (Cœlenterata with urticating organs): 1. Anthozoa; 2. Archydræ; 3. Hydromedusæ; 4. Ctenophora.

As Herr Miklucho is about to publish his beautiful observations on sponges, in which he will demonstrate the community of descent of the Sponges and Acalephæ, I confine myself here to this short notice.[2] I have mentioned them here because it seems to me that a great gain has been attained in classification by the removal of the Sponges from the remaining Protista, and by their union with the true animals. In particular, it now becomes possible to define my Protista kingdom by a decided and important character, and to separate it from the true animals and the true plants: this character is the total absence of sexual reproduction. In nearly all indubitable plants, as well as in all indubitable animals, sexual reproduction (amphigony) is present. On the other hand all true Protista (all the above-mentioned groups except the Sponges) multiply exclusively by a non-sexual reproduction (monogony). If we extend this definition to the genealogical individuality of the first order, to the cycle of

[1] Aristotle's original definition Acalephæ, or Cnidæ, may be the most admissible definition for the true Cœlenterata (with the exception of the Sponges) because, on the one hand, it already expresses their most essential character, the possession of urticating organs; and on the other, because Aristotle already included under this definition the two different types of Cœlenterata, the fixed Petracalephæ (Actinia) and the freely swimming Nectacalephæ (Medusæ), *αἱακαλῆφαι, αἱ κνίδαι*.

[2] A special light becomes thrown, by this community of descent, upon the recently so much talked-of Hyalonema. Perhaps in the end the sponge and parasitic polyp may be connected, and Hyalonema be a direct descendant of the common original group of Sponges and Acalephæ?

generation (*Cyclus generationis*) of all the three organic kingdoms, then the cycle of generation of animals and plants is an amphigenesis, while, on the other hand, the cycle of generation of the Protista is a monogenesis. (On this, compare 'Generelle Morphologie,' vol. ii, pp. 70, 83.)

If, on the ground of this criterion, we would strictly bring to an issue the separation of the three kingdoms, we must include in the Protista a few groups of the lowest organisms, which hitherto rank among the true plants, but in which sexual reproduction is absent. This can be done so much the sooner, as, independently of this, in them the main decisive vegetable characters are obliterated, and they present close relations instead with several groups of Protista. Above all, one would be justified in removing the large and multiform class of Fungi from the vegetable kingdom, and placing them near Myxomycetes among the Protista. The whole method of nourishment and assimilation of the fungi, in connection with many other characters (especially the total absence of chlorophyll), remove them so far from the true plants that the earlier botanists long since wished to establish for the fungi a special organic kingdom.

On similar grounds one would also be enabled to rank the Phycochromaceæ (Chroococcaceæ and Oscillarineæ) as a group of Protista, and, perhaps, also the Codiolaceæ (Codiolum, &c.). On the other side, the Volvocineæ, distinguished by their sexual reproduction, must be separated from the Flagellata and placed with the true Algæ. Many transpositions of this sort must ere long occur, according as our knowledge of one group or another becomes apparently more complete. But in no case shall we, as I think, ever succeed in erecting an absolute wall of separation between the animal and vegetable kingdoms, and be able to refer a portion of the Protista with absolute certainty to the plants, and another to the animals. Also, by my proposed entire systematic separation of the three kingdoms, the practical end of a differential diagnosis is made easier, and an absolute separation of Animals, Protista, and Plants, as three fundamentally different organic groups, is by no means maintained. Rather do I abide by the conjecture put forward in my 'Generelle Morphologie' that both the animal and vegetable kingdoms have derived their first root from one or several Protista groups, while other Protista groups (*e. g.* Diatomaceæ, Myxomyceta, Rhizopoda) have developed themselves independently and unconnected with these. Finally, that all organic stems may have been connected at their oldest root is likewise very conceivable. The

controversy how many original protistic phyla or radical forms may have given origin to the races of animals, plants, and the existing races of protista, loses much of its apparent importance from the oldest original forms of all organisms, having manifestly been Moners of the simplest and most indifferent kind, structureless and homogeneous, shapeless lumps of sarcode, originating from Archigony or equivocal generation.

As is shown by the Moners described by myself and Cienkowski, it is quite impossible to unite them with any manner of safety to any other established group of Protista, or to consider them with certainty as either animals or plants. In the passive state, and during reproduction, they have more of a vegetable, and in the active state, and when taking nourishment, more of an animal, character. But on the whole they are, by their very simple nature, such indifferent organisms that they might be considered as the first beginnings of any given living organic race (phylum). What a great analogy these display, in this respect, with the various groups of Protista will be best understood from the following morphological comparison of the Monera with the various groups of Protista.

Before we proceed to this, it seems advisable once more to enumerate the various organic stems which compose the kingdom of the Protista in its just defined limits. I repeat again, that I consider this "system of Protista," in every point of view, as only an entirely provisional attempt, and as an inducement to fresh investigation.

Kingdom of the Protista, or of Monogenetic Organisms (organisms which reproduce themselves exclusively in a non-sexual manner, by monogony).

Group I. MONERA.

1. Gymnomonera (Protogenes, Protamœba, &c.).
2. Lepomonera (Protomonas, Vampyrella, Protomyxa, &c.).

Group II. FLAGELLATA.

1. Nudiflagellata (Euglena, Spondylomorum, &c.).
2. Cilioflagellata (Peridinium, Ceratium, &c.).

Group III. LABYRINTHULEA (Labyrinthulæ).

Group IV. DIATOMEA (Bacillaria).

Group V. PHYCOCHROMACEA (Myxophycea).

1. Chroococcacea (Glœocapsa, Merismopœdia, &c.).
2. Oscillarinea (Nostochacea, Rivulariacea, &c.).

Group VI. FUNGI (Mycetes).

1. Phycomycetes (Saprolegnieæ, Mucorinæ, &c.).
2. Hypodermiæ (Uredineæ, Ustilagineæ, &c.).
3. Basidiomycetes (Hymenomycetes, Gastromycetes, &c.).
4. Ascomycetes (Protomycetes, Discomycetes, &c.).

Group VII. MYXOMYCETES (Mycetozoa).

Group VIII. PROTOPLASTA (Amœboida).

1. Gymnamœbæ (Autamœba, Nuclearia, &c.).
2. Lepamœbæ (Arcella, Difflugia, &c.).
3. Gregarinæ (Monocystida et Polycystida).

Group IX. NOCTILUCÆ (Myxocystoda).

Group X. RHIZOPODA.

1. Acyttaria (Monothalamia et Polythalamia).
2. Heliozoa (*Actinosphærium Eichhornii*).
3. Radiolaria (Monocyttaria et Polycyttaria).

V. *Comparative Morphology of the Monera.*

In order rightly to estimate the complicated relations of the Monera to the rest of the Protista, and especially to the organisms of the lowest rank, it next appears requisite to enter into explanations concerning their morphological, or, more correctly, their tectological importance, and to define their individual position. I add to this the consideration of the position which I have developed and established in my general tectology, or doctrine of the individuality (structural doctrine) of organisms.[1]

As the universal and single indispensable material element of all organisms, we have indicated the plasma or protoplasm (sarcode), a semifluid, nitrogenous, carbonaceous compound of the group of albuminous bodies.

In the Monera, the very lowest of all organisms, this plasma forms (simply and solely by itself, without combining with other bodies) the whole structureless body of the fully developed organism.

[1] 'Generelle Morphologie,' vol. i, Drittes Buch., ix cap., p. 269.

So far as the value of its form is concerned, it thus represents the very simplest morphological individual of the first order, a lump of plasma or a plastide. The variously interpreted definition of the organic cell is, according to the ordinary form of speech, no longer applicable to these very simple individualised morsels of plasma. In order, therefore, to make the cell theory, that indispensable foundation of our common tectology, applicable also to the Monera and the allied Protista, I have tried to define the relation of these morsels of plasma to true cells as sharply as possible in my tectology. According to my view, true cells, for the definition of which I imagine necessary the separation of inner nucleus and outer plasma, have arisen from Monera by an *inner* differentiation. On the other hand, cell-like, but non-nucleated, plastides—membranous cytodes—have originated from Monera by an *outer* differentiation of plasma and enclosing membrane or shell.

By this systematic division we obtain the following four essentially different elementary forms of Plastides, or of morphological individuals of the first order:

Kinds of Plastides.

I. Cytodæ (or Cellinæ), Cytodes, plasma-masses without a nucleus.

1. Gymnocytodæ (or *Cytodæ nudæ*), naked Cytodes.

Naked plasma-masses without a nucleus, without a membrane or shell; for example, the freely moving Monera, the non-nucleated plasmodia of the Myxomyceta, and of several other Protista, the amœboid germs of the Gregarinæ proceeding from Pseudonavicellæ, &c.

2. Lepocytodæ (or *Cytodæ membranosæ*), covered Cytodes.

Encysted plasma-masses without nucleus, enclosed in an entire or incomplete membrane or shell; for example, the encapsuled resting condition of the Lepomonera, many Siphoneæ, and numerous other of the lower plants, the so-called "non-nucleated cells" of many higher plants and of many animal tissues.

II. Cellulæ, (or Cyta) Cells, plasma-masses with nucleus.

1. Gymnocyta (or *Cellulæ nudæ*), naked cells.

Naked plasma-masses with nucleus, without membrane or shell; for example, the true Amœbæ (Autamœbæ), the naked zoospores of Algæ, the eggs of Siphonophora and other ani-

mals, the colourless blood-cells, many nerve-cells, and very many other cells of animals in general, &c.

2. Lepocyta (or *Cellulæ membranosæ*), covered cells.

Encysted plasma-masses with nucleus, enclosed in an entire or incomplete membrane or shell; for example, the Diatomaceæ, most young plant-cells (as long as they still possess a nucleus), the eggs of most animals, and many animal cells in general, &c.

Manifestly the great interest of the Monera especially consists in their being Gymnocytodes, *i. e.* Plastides of the simplest of all kinds, and in the fact that all the above-mentioned kinds of Plastides, as they form the bodies of all organisms, are based upon them. Phylogeny, the palæontological development-history of the organic stems (Phyla), is necessarily at last compelled to go back to the archigonic (originating by spontaneous generation) Monera for the first groundwork of all the various groups of organisms. From the Gymnocytodes, as the original plastide-forms (the very simplest, perfectly homogeneous, masses of plasma), originate, on the one side, by outer differentiation of plasma and membrane, the Lepocytodes, on the other side, by inner differentiation of plasma and nucleus, the cells; and these last then again divide into covered and naked cells, according as they are surrounded by a membrane or not. To these four primary forms of Plastides all other cells and cell-forms, and, generally speaking, all histological elements, can be reduced, as I have more fully developed in my General Tectology ('Gen. Morph.,' vol. i, pp. 269—303).

Let us now fix, by this scale, the morphological importance of all hitherto discovered forms of Monera, as I have classed them synoptically in the last section of this memoir, and we shall arrive at the following results:

1. All Monera remain for their lives cytodes; they never develop into the higher condition of the cell, since nuclei are never differentiated in their protoplasm.

2. All Monera are, in their full-grown and freely moving condition, Gymnocytodes; in this condition they never possess a membrane, or shell, or other envelope.

3. The Gymnomonera (Protogenes, Protamœba, and perhaps, also, Myxodictyum?) remain throughout their lives Gymnocytodes; they do not pass into a resting condition, and they do not surround themselves with a covering.

4. The Lepomonera (Protomonas, Protomyxa, Vampyrella, Myxastrum), from being originally Gymnocytodes, become afterwards Lepocytodes, during which they pass into

a resting condition for the purpose of reproduction, and then surround themselves with a covering or shell.

5. Some Monera (Protogenes, Protamœba) remain, throughout their lives, single isolated cytodes, permanent individuals of the first order, in that the new individuals (Bionta), originating by the reproductive process, forthwith separate themselves from the older organism, or in that this latter simply divides itself into two parts.

6. Other Monera (Myxodictyum and all Lepomonera) form temporarily individuals of the second order, or organs (in a purely morphological sense), in that, during the time of reproduction the newly formed individuals (zoospores, Tetraplasta, and other forms of germs) remain for some time united in one Cytode colony (organ).

In these six statements are comprised the complete morphological characteristics of the Monera. To these must be added the physiological criterion of an exclusively non-sexual reproduction. If we now compare, with constant reference to these characteristic peculiarities, the Monera with other organisms, and especially with the nearest allied Protista, we shall, on the one hand, recognise more easily the special character of the group Monera, and, on the other, its multiform relationships to the remaining groups. I shall, then, separately compare with them the series to which the Monera are the nearest allies among the previously enumerated Protista groups.

I. *Monera and Rhizopoda.*

The true Rhizopoda stand nearest of all organisms to the Monera, with, perhaps, the exception of Protamœba. I thus limit the natural groups of the true Rhizopoda, as I have done in my 'General Morphology' (after the removal of the Protoplasta or Amœboida), to the three classes of the Acyttaria (Monothalamia and Polythalamia, or Imperforata and Perforata), the Heliozoa (at present formed only of the remarkable *Actinosphærium Eichhornii*, Stein, *Actinophrys Eichhornii*, Ehrenberg), and the Radiolaria (Monocyttaria and Polycyttaria). The majority of these true Rhizopoda are distinguished from the Monera by the possession of a skeleton or a shell when in their freely moving and perfectly developed condition. The few remaining Rhizopoda which do not possess this skeleton or shell (Actinosphærium, Thalassicolla, Physematium, Collozoum) are separated from the Monera by the differentiation of nuclei in the interior of their plasma-body. A very peculiar position must be assigned to the very common *Actinophrys sol* (Ehrenb.), which is usually

classed with the Rhizopoda, and the only certainly known representative of the true Actinophrys. I should prefer to transfer this organism to the Monera, and to place it between Vampyrella and Myxastrum. The peculiar very large contractile vesicle of this Protiston would then have to be considered as a mere vacuole. But, as in spite of the *Actinophrys sol* being very common, we still continue to know nothing certain of its reproduction and development, its position among the Monera must at present still remain doubtful. The resting condition of *Actinophrys sol* observed by Cienkowski (l. c., p. 227), renders its position among the Monera still more probable. It might probably be in future advisable, also, to add to the Monera, besides the true *Actinophrys sol* (Ehrenb.), a number of nearly allied Actinophrys-like Protista, such as Trichodiscus and Plagiophrys.[1] The newly described Clathrulina of Cienkowski, which I have also observed near Jena, I consider a true Rhizopod, and place it with the Monothalamia, among the Acyttaria.[2]

II. *Monera and Flagellata.*

Among the various forms of Monera, the zoospores of Protomonas and Protomyxa show the greatest resemblance to the simplest forms of Flagellata. The latter are distinguished by the presence of nuclei and of envelopes. The developed and freely moving Flagellatum is never a Gymnocytode, as all Monera are in their freely moving condition.

III. *Monera and Labyrinthulea.*

Among the Monera, Myxastrum, in its reproductive state, strongly reminds us of Labyrinthula. But the individual Plastides of the latter are always nucleated, and thus are true cells, while the Monera never possess nuclei.

IV. *Monera and Diatomaceæ.*

The spindle-shaped siliceous-shelled spores of Myxastrum remind us of the Diatomaceæ also, as they do of the

[1] *Actinosphærium Eichhornii* (Stein), which as *Actinophrys Eichhornii*, Ehrenb., *not* Kölliker, is still generally confounded with the true *Actinophrys sol* (Ehrenberg; *Actinophrys Eichhornii*, Kölliker), is very widely different from it. In *Actinophrys sol* the entire protoplasm body is, as in the Monera, structureless, while in *Actinosphærium Eichhornii* we have a true Rhizopod, in which nucleus-containing cells have already differentiated themselves in the outer substance of the body.

[2] Cienkowski, "Ueber die Clathrulina, eine neue Actinophryen-Gattung;" 'Archiv für mikrosk. Anatomie,' 1867, pp. 311, 316, Taf. xviii.

Labyrinthulea, especially of the simplest form of Navicula. But as the Diatomaceæ are also always (?) nucleated, and as, so far as they are known, they never appear as naked Plastides, their differences from the Monera are very decisive.

V. *Monera and Myxomycetes.*

Among all Protista, next to the true Rhizopoda, the Myxomyceta stand nearest to the Monera. The colossal naked, freely moving sarcode bodies of Protogenes, Protomyxa, and also of Vampyrella, are not in themselves to be directly distinguished from the plasmodia of the Myxomycetes, especially the semi-liquid forms. Only their further development allows us to perceive the divergence of the two groups. There is, in addition, the striking similarity of the reproduction by zoospores in Protomonas and Protomyxa. Hence these might be considered as the simplest Myxomycetes. But the spore of the Myxomyceta always encloses a nucleus, and is, therefore, a true cell, while in the Monera nuclei are never present. In this I recognise the substantial difference between the Monera and Myxomyceta, apart from the much higher differentiation of the sporangium in the latter. But one might consider the encapsuled resting condition of Protomyxa as the first and simplest commencement of the sporangium of the Myxomycetes. In both the zoospores pass over into the Amœba condition.

VI. *Monera and Protoplasta.*

The Protoplasta, also, show, like the Myxomyceta and Rhizopoda, very close relations to the Monera. I have classed together as Protoplasta, in my 'General Morphology,' the three following groups of Protista:

1. Gymnamœbæ, the true, naked Amœbæ, with a nucleus, and with or without a contractile vesicle or vacuole; Autamœba, Nuclearia, Pseudospora, Podostoma, Petalopus, &c.
2. Lepamœbæ (Amœbæ furnished with a shell or test; Arcella, Difflugia, Euglypha, &c.).
3. Gregarinæ (Monocystidea and Polycystidea).

I regard the Gregarinæ as Amœbæ which have degenerated by parasitism. The Monera show the closest affinities to the Protoplasta, especially to the Gymnamœbæ. Protamœba is only to be distinguished from the true Amœbæ (Autamœba) by the absence of a nucleus and of the contractile vesicles. The pseudo-navicellæ of the Gregarinæ remind us extremely, (still more than the "spindles" of the Labyrinthulea,) of the spindle-shaped spores of Myxastrum. But there is, again, an

essential and decisive difference in true cell-nuclei being differentiated in the substance of the sarcode in all Protoplasta, while this is never the case in the Monera.

The three remaining groups of Protista, the Phycochromaceæ, Fungi, and Noctilucæ, show less decided relations to the Monera than the six groups just considered, and a special comparison of them is, therefore, superfluous. But the lowest Fungi, as well as the simplest Phycochromaceæ, are immediately allied to the Monera by the simplicity and the lower grade of development of their structure and of their life-phenomena. Their simplest ancestors may have proceeded directly from Monera.

In any case, it becomes even now perfectly clear from the sketch above given, and from a simple comparison of the history of the development of the different Protista that, without a complete knowledge of their individual development-history, these very low organisms cannot at once be referred with even approximate certainty to this or that group of Protista. This especially and peculiarly applies to all naked Amœba-like and Actynophrys-like bodies, as well as to the Myxomyceta-like plasmodia, and to the Flagellata-like zoospores. Here, as everywhere in morphology, as Baer says, "the history of development is the true Guide-light for investigations into organic bodies." But none the less is the weighty proposition also verified here, "*that the theory of descent is the true Guide-light for the whole history of development.*"

VI.—*Systematic arrangement of the Monera.*

Character of the groups of Monera .—

Organisms without organs, which in their perfectly developed condition form a freely moving, naked, perfectly structureless and homogeneous mass of sarcode (Protoplasm). Nuclei are never differentiated in the homogeneous protoplasm. Movement is effected by contraction of the homogeneous substance of the body, and by the protrusion of processes (pseudopods) varying in form, which either remain simple or ramify and anastomose. Nutrition is effected in various ways, mostly after the manner of the Rhizopoda. Reproduction is effected solely in a non-sexual manner (by monogony). Often, but not always, the freely moving condition alternates with a state of rest, during which the body surrounds itself with an excreted structureless covering. All Monera live in water.

First division of the Monera.

GYMNOMONERA.

Monera without a resting condition, and without formation of a covering.

The freely moving condition of the Moner is interrupted by no resting condition with formation of a covering.

Genus I.—PROTAMŒBA, Haeckel.[1]

Haeckel, 'Generelle Morphologie,' 1866, vol. i, p. 133.

Generic character.—A simple shapeless protoplasm body without the formation of vacuoles, which protrudes simple processes, not ramifying or anastomosing, and which reproduces itself by fission.

Species.—Protamœba primitiva, Haeckel.

Plate X, fig. 25—30.

'Generelle Morphologie,' 1866, vol. i, p. 133.

Protoplasm-body of 0·03—0·05 mm. diameter, continually varying in form, with one or several (3 to 6) peripheral pseudopods. Processes short, rounded, obtuse, finger-shaped, at most as long as the diameter of the central body.

Locality.—A pond of fresh water in Tautenburg Forest, opposite Dornburg, near Jena. 1863 and 1865.

Genus II.—PROTOGENES, Haeckel.[2]

'Zeitschr. für. wissensch. Zool.,' vol. xv, 1865, p. 360.

Generic character.—A simple shapeless protoplasm-body without the formation of vacuoles, which protrudes ramifying and anastomosing processes, and reproduces itself by fission.

Species.—Protogenes primordialis, Haeckel.

'Ueber den Sarcodekörper der Rhizopoden,' l. c., p. 360, pl. xxvi, figs. 1, 2.

Protoplasm-body sometimes contracted globularly, from 0·1—1 mm. diameter (l. c., fig. 1); sometimes extended and flattened out, of an irregular outline, of 3—4 mm. diameter (fig. 2); pseudopods exceedingly numerous (over a thousand), very fine, with very numerous ramifications and anastomoses.

Locality.—Mediterranean, near Nice, 1864.

[1] Πρώτη αμοιβή, the first change of form.
[2] Πρωτογενής, the first-born.

Genus III.—Myxodictyum, Haeckel.[1]

(See p. 131, above.)

Generic character.—Several simple shapeless protoplasm-bodies, (without the formation of vacuoles,) which protrude ramifying and anastomosing pseudopods, and link themselves by these anastomoses into a net. (Reproduction probably proceeds by division, and by the detachment of the single individuals, which then form new colonies?)

Species.—Myxodictyum sociale, Haeckel.

See Plate X, figs. 31—33.

Protoplasm-body in the only observed specimen, forming a flat broadened-out sarcode-net of 0·35mm. diameter, composed of seventeen individual Moners, actinophrys-like bodies of 0·04 mm. diameter.

Locality.—Bay of Algesiras in the Straits of Gibraltar, 1867.

Second division of the Monera.

Lepomonera.

Monera with a resting condition, and with formation of a covering.

The freely moving condition of the Moner is interrupted by a resting condition, with the development of a covering.

Genus IV.—Protomonas, Haeckel.[2]

'Generelle Morphologie,' vol. ii, p. xxiii.

Generic character.—A simple shapeless protoplasm-body (without the formation of vacuoles), which protrudes simple or ramifying pseudopods. Reproduction by zoospores, which combine into plasmodia.

Species.—Protomonas amyli, Haeckel.

(*Monas amyli*, Cienkowski.)

'Archiv für Mikrosk. Anat.,' vol. i, p. 165, pl. xii, figs. 1—5.

Protoplasm-body, a plasmodium which arises from the

[1] μυξοδικτυον, slime-net.

[2] Πρωτομονας, first beginning.

fusion of several zoospores, of about 0·02—0·05 mm. diameter, with a few ramifying, very fine pseudopods.

Resting condition, a roundish Lepocytode, whose membrane throws out wedge-shaped warts, which project inwards. Zoospores spindle-shaped, very contractile, furnished with several (two ?) flagella, moving themselves in the manner of an Anguillula.

Locality.—In decaying Nitella from fresh water in Germany and Russia (Cienkowski).

Genus V.—Protomyxa, Haeckel.[1]

(Compare above, p. 34.)

Generic character.—A simple shapeless protoplasm-body (with the formation of vacuoles), which protrude ramifying and anastomosing pseudopods. Reproduction by zoospores, which combine together into plasmodia.

Species.—*Protomyxa aurantiaca*, Haeckel.

See Plate IX, figs. 1—12.

Protoplasm-body, a plasmodium of orange-red colour, which (always ?) originates from the fusion of several zoospores, of 0·5—1 mm. diameter; with very numerous and very thick ramifying and anastomosing pseudopods, which form a network by many anastomoses. Resting condition, a globular Lepocytode of 0·15 mm. diameter, with a thick structureless covering (cyst). Zoospores pear-shaped, at the pointed end cone-shaped, produced into a very strong flagellum, at first moving in the manner of the zoospores of the Myxomyceta, and afterwards creeping along in the manner of an Amœba.

Locality.—On empty shells of *Spirula Peronii* floating about on the open sea, and driven in on the coast of the Canary Island Lanzarote, 1867.

Genus VI.—Vampyrella, Cienkowski.[2]

'Archiv für. Mikrosk. Anat.,' vol. i, p. 218.

Generic character.—A simple shapeless protoplasm-body (without the formation of vacuoles), which protrudes simple or ramifying pseudopods. Reproduction by the formation of tetraplasta; the encapsuled resting body divides first into

[1] Πρωτόμυξα, original slime.
[2] Diminutive of Vampyrus.

two, then into four germs, which, after their exit from the cyst, are Actinophrys-like bodies.

Species 1.—*Vampyrella Spirogyræ*, Cienkowski.

'Archiv für Mikrosk. Anat.,' vol. i, p. 218, pl. xii, figs. 44—56.

Protoplasm-body of brick-red colour, and of exceedingly variable and irregular form. Pseudopods with granular circulation, partly long, thin, and pointed, partly short, thick, and obtuse. The pseudopods bore into the cells of Spirogyra, and suck out their contents. Resting condition, a globular or spheroidal, rarely an irregularly shaped Lepocytode, of 0·06 mm. diameter, fixed to Spirogyræ. Cyst-wall consisting of cellulose (turned blue by iodine and sulphuric acid).

Locality.—On a fresh-water species of Spirogyra, Cienkowski.

Species 2.—*Vampyrella pendula*, Cienkowski.

'Archiv für Mikrosk. Anat.,' vol. i, p. 221, pl. xii, figs. 57—63.

Protoplasm-body of brick-red colour, and of very variable form. "Pseudopods without granular-circulation," which bore into the cells of various Confervæ, Œdogonia, Bulbochætæ, &c., and suck out their contents. Resting condition, a pear-shaped Lepocytode, which is attached by the pointed extremity. From the encysted globularly contracted body, a thread-like process issues to the place of attachment through the pointed end of the cellulose cyst-wall.

Locality.—On various fresh-water Confervæ.

Species 3.—*Vampyrella vorax*, Cienkowski.

'Archiv für Mikrosk. Anat.,' vol. i, p. 223, pl. xii, figs. 64—73.

Protoplasm-body of brick-red colour, and of extremely irregular and variable form. "Pseudopods without granular circulation." It engulphs foreign bodies (Diatomaceæ, Desmidiaceæ, and Flagellata) in the manner of the Rhizopoda, and draws them into the interior of the body. Resting condition an irregular, mostly longitudinally extended Lepocytode.

Locality.—In fresh water.

Genus VII.—MYXASTRUM, Haeckel.[1]

(See above, p. 123.)

Generic character.—A simple shapeless protoplasm-body (without the formation of vacuoles), which protrudes simple or ramifying and anastomosing processes. Reproduction by radial fission. The encapsuled resting body divides into a great number of longish germs, whose longitudinal axis is radially directed towards the centre of the globular cyst. Each separate germ surrounds itself with a siliceous covering. The germs issuing from these spore-coverings at once assume the form of the full-grown organism.

Species.—Myxastrum radians, Haeckel.

Plate X, figs. 13—24.

Protoplasm-body in the freely moving condition, usually of the shape of a radiating ball, of very tough consistence, of 0·3—0·5 mm. diameter. Pseudopods very tough and stiff, ramifying sparingly, with few anastomoses. Foreign bodies, Diatomaceæ, Peridinia, &c., are engulphed by the pseudopods, and drawn into the central body. Resting condition, a globular cyst of 0·08 mm. diameter. The contents divide into numerous siliceous-shelled spores of 0·03 mm. length, 0·015 mm. breadth, whose longitudinal axes are radially directed towards the empty centre of the globular cyst.

Locality.—Beach of the harbour of Puerto del Arrecife, the port of the Canary Island Lanzarote, 1867.

ENUMERATION *of* MICRO-LICHENS *parasitic on other* LICHENS. By W. LAUDER LINDSAY, M.D., F.R.S.E., F.L.S.

(*Continued from page* 146.)

Genus XV.—ACOLIUM, *Ach.* Mudd, 253.

Species 1. *A. corallinum,* Hepp.
Syn. *Cyphelium,* Hepp, 531.
Trachylia, Hepp.
Sclerococcum sphærale, Fr.
Celidium furfuraceum, Anzi.

[1] μύξα ἄστρον, slime-star.

On thallus of *Lecanora glaucoma*, var. *corallina*, L. (Hepp); and *Pertusaria ocellata*, var. *corallina*, Körb. (Par., 465).[1]

Spores spherical, simple, brown. A *Fungus* according to Fries (Syst. Myc., iii, 257); and Nylander (Prod., 91), who refers it to the genus *Spilomium* (*Uredineæ*), a genus which includes other Micro-fungi parasitic on Lichens.

Genus XVI.—Cercidospora, *Körb.*, Par., 465.

Species 1. *C. Ulothii*, Körb., Par., 466.

On thallus of *Squamaria saxicola* (Körb.), and on apothecia of *Lecanora polytropa* (Th. Fries, L. Spitsb., 22).

Spores 4, fusiform, 2-locular, colourless.

Genus XVII.—Pharcidia, *Körb.*, Par., 469.

Species 1. *P. congesta*, Körb., Par., 470.

Syn. *L. subfusca*, v. *pharcidia*, Ach.

On apothecia of *Lecanora subfusca*, and var. *intumescens*, Fw.

Spores 8, 2—4-locular, colourless, linear or rod-shaped.

Genus XVIII.—Polycoccum, *Saut.* Körb., Par., 470.

Species 1. *P. Sauteri*, Körb., Par., 470.

Syn. *P. condensatum*, Saut.

Catopyrenium, Hampe.

On protothallus of *Stereocaulon condensatum*.

Spores 8, small, 2-locular, brown.

Genus XIX.—Sorothelia, *Körb.*, Par., 471.

Species 1. *S. confluens*, Körb., Par., 472.

On thallus of *Phlyctis argena*.

Spores 8, soleaform (2-locular), brown.

Genus XX.—Rhagadostoma, *Körb.*, Par., 472.

Species 1. *R. corrugatum*, Körb., Par., 472.

On thallus of *Solorina crocea*.

[1] It appears to me that the host, on which the parasite usually occurs, is the common *Isidium corallinum*, Ach., which is apparently a mere condition of *several very different* Lichens, e. g.—

1. *Pertusaria syncarpa*, Mudd,
   var. *corallina*, L.; Mudd, 273.
2. *P. ocellata*, Wallr.,
   var. *corallina*, Ach.; Körb., Par., 311.
3. *Lecanora glaucoma*, Ach.,
   var. *coralloidea*, Fw.; Körb., Par., 89; Fries, 378; Schær., 71.

Spores 2—4 (in lanceolate fugacious thecæ), large, simple, becoming 2-locular, colourless.

Genus XXI.—Spolverinia, *Mass.* Körb., Par., 473.

Species 1. *S. punctum*, Mass. Körb., Par., 474.
On the thallus and protothallus of various crustaceous Lichens.
Spores 1—2, large, globose-ovoid, simple, colourless or yellowish.

Genus XXII.—Placographa, *Th. Fries.* Körb., Par., 249.

Species 1. *P. xenophona*, Körb., Par., 464.
On thallus of *Lecidea contigua* and var. *albo-cærulescens*.
Spores 8, small, ovoid-ellipsoid, simple, colourless.

Genus XXIII.—Lahmia, *Körb.*, Par., 281.[1]

Species 1. *L. Fuistingii*, Körb., Par., 464.
On thallus of *Bæomyces placophyllus*.
Spores 4, large, acicular, 8—12-locular, colourless.

Genus XXIV.—Xenosphæria, *Trevis.* Körb., Par., 466.

Species 1. *X. Engeliana*, Saut. Körb., Par., 466.
Syn. *Sphæria urceolata*,[2] Anzi; Linds., N. Z. Lich. and Fungi, 438; Hepp, 475, f. 2.
Endocarpon, Schær.
E. psoromoides, Hook. and Leight.; Borr., pr. p.
Verrucaria Sauteri, Hampe.
Dacampia, Körb., Syst., 326.
Sagedia, Saut.
On thallus of *Solorina saccata*.
Spores 6—8, oblong, 4—6-locular, brown: sometimes large, irregular, and muriform. Körber (Syst., 326) describes it as possessed of a proper thallus.

Genus XXV.—Arthopyrenia, *Mass.* Körb., Par., 386.

Species 1. *A. conspurcans*, Th. Fr., Spitsb., 51.
On thalline scales of *Lecidea globifera*, v. *rubiformis*, Whlb.

[1] Possesses spermogonia.
[2] Compare *Phacopsis psoromoides*.

Spores 8, cuneate, 2-locular, colourless.

2. *A. dispersa*, Lahm; Körb., Par., 388.

On thallus of *Lecanora calva*, Dicks.

Spores 8, small, soleaform (2-locular), colourless.

3. *A. Aspiciliæ*, Lahm; Körb., Par., 388.

On thallus of *Lecanora calcarea*.

Spores 8, oblong, 2—4-locular, colourless. Lahm suggests it may be identical with *Thelidium aggregatum*, Mudd (q. v.).

4. *A. microspila*, Körb., Par., 392.

On thallus of *Graphis scripta*.

Spores 6—8, minute, cuneate, 2- (rarely 4-) locular, colourless.

Genus XXVI.—THELOCARPON, *Nyl.*, Pyren., 9.

Species 1. *T. epithallinum*, Leight., Ann. Nat. Hist., vol. xviii, 1866, p. 24.

Syn. *T. Laureri*, Flot.; Leight., "New British Lichens," Ann. Nat. Hist., 1864.

On thallus of *Bæomyces rufus*.

Spores numerous, minute, ellipsoid, physcioid, colourless.

Genus XXVII.—LECIOGRAPHA, *Mass.* Körb., Par., 463.

Species 1. *L. Neesii*, Fw.; Körb., Par., 463.

Syn. *L. Zwackhii*, Mass.
Peziza Neesii, Fw.

On sterile thallus of *Lecidea commutata*, Ach.; *Lecanora elatina*, Ach.; and *Phlyctis argena*, Flk.

Spores 8, fusiform, 4-locular, colourless, becoming brown.

2. *L. parasitica*, Mass.; Körb., Par., 463.

On thallus of *Lecanora calcarea*.

Spores 8, ellipsoid, 4-locular, brown.

Genus XXVIII.—KARSCHIA, *Körb.*, Par., 459.

Species 1. *K. talcophila*, Ach.[1]

Syn. *Buellia*, Körb., Syst., 230.
Abrothallus, Mass.
Calicium complicatum, Fw.
Lecidea, Fw.

On thallus of *Urceolaria scruposa*.

[1] Compare *Tichothecium Arnoldi*, which Hepp apparently refers to this lichen.

Spores 8, minute, soleaform (2-locular), brown. Körber describes it as sometimes possessing a proper thallus.

2. *K. pulverulenta*, Anzi; Körb., Par., 460.

Syn. *Abrothallus*, Anzi.

On thallus of *Physcia pulverulenta*.

Spores as in preceding.

3. *K. protothallina*, Anzi; Körb., Par., 460.

Syn. *Abrothallus*, Anzi.

On protothallus of *Pannaria lepidiota*, Th. Fr.

Spores 6—8, small, 2-locular, deep brown.

4. *K. Strickeri*, Körb., Par., 460.

On the gonimic thallus of *Lecidea pineti*.

Spores 8, small, soleaform (2-locular), brown. Plant has the aspect of a *Peziza*.

Genus XXIX.—Nesolechia, *Mass.* Körb., Par., 461.

Species 1. *N. punctum*, Mass.; Korb., Par., 461.

On protothallus of various *Cladoniæ*.

Spores 6—8, small, linear-fusiform, simple, colourless.

2. *N. ericetorum*, Fw.; Körb., Par., 461.

Syn. *Stigmatidium*, Fw.

On thallus of *Bæomyces roseus* and *B. rufus*.

Spores 6—8, small, ellipsoid, simple, colourless. Körber thinks it identical with *Lecidea inquinans*, Tul. (q. v.). He did not find spermogonia associated with it.

3. *N. thallicola*, Mass.; Körb., Par., 462.

Syn. *Scutula*, Anzi.

On thallus of *Parmelia caperata*.

Spores 8, small, ovoid-ellipsoid, simple, colourless.

4. *N. Nitschkii*, Körb., Par., 462.

On thallus of *Thelotrema lepadinum*.

Spores 4—8, small, oblong, simple, colourless.

Genus XXX.—Thelidium, *Mass.* Mudd, 294.

Species 1. *T. aggregatum*, Mudd, 298.[1]

On thallus of *Lecanora calcarea*.

Spores large, linear-oblong, 2-locular, colourless.

2. *T. epipolytropum*, Mudd, 298.

On thallus of *Lecanora polytropa* and *Squamaria saxicol*

Spores subfusiform, 2-locular, colourless.

[1] Compare *Arthopyrenia Aspiciliæ*.

Genus XXXI.—Tichothecium, *Fw.* Körb., Par., 467.

Species 1. *T. pygmæum*, Körb.

Syn. *Microthelia*, Körb., Syst., 374; Mudd, 307.
Endococcus,[1] Th. Fries., Spitsb., 51; Arct., 275.
Verrucaria gemmifera, var., Leight.
Tichothecium Rehmii, Mass.
Sphæria lichenicola, Auctt., pr. p.

On thallus of many saxicolous (crustaceous and subfoliaceous) Lichens, *e. g.*:

Placodium elegans, DC.; *albescens*, Hffm.; *cirrochroum*, Ach.; *fulgens*, DC.
Lecanora calcarea and var. *Hoffmanni*, Ach.; *calva*, Dicks; *polytropa*.
Lecidea contigua, and var. *meiosperma*, Nyl. (= *L. parasema*, v. *crustulata*, Ach.); *fusco-atra*, Ach.; *sabuletorum*, Schær.; *polycarpa*, Flk.; *lapicida*; *geographica*.
Pyrenodesmia rubiginosa, Kremph.

Spores numerous (32—50), very minute, oblong-ellipsoid, 2-locular, brown. Mudd describes it as having occasionally a proper thallus. Much more common than the following: occurring both on apothecia and thallus (Th. Fries).

2. *T. gemmiferum*, Tayl.; Körb., Par., 468.

Syn. *Verrucaria*, Tayl.; Leight.
Endococcus, Nyl.; Leight., Exs., 137; Th. Fries, Spitsb., 51; Arct., 275.
Phæospora, Hepp, 700.
Microthelia propinqua, Körb., Syst., 374; Mudd, 307.
Sphæria lichenicola, Auctt., pr. p.

On thallus of various saxicolous Lichens, e. g. *Lecidea contigua* and var. *meiospora*; *L. fusco-atra*; *L. confluens*, Ach.; *L. sabuletorum*; *L. parasema*, v. *latypea*, Ach. (= *L. coniops*, Ach., pr. p.); also on various *Lecanoræ*, e. g. *L. cinerea* (fide Th. Fries), *L. atra* (fide Mudd).

Spores 8—12, ellipsoid, minute, 2-locular, brown. Mudd describes the plant as sometimes having a proper thallus.

3. *T. erraticum*, Mass.; Körb., Par., 468.

Syn. *Endococcus*, Mass.; Nyl.

On thallus of *Lecanora chalybæa*, Schær., and *L. auran-*

[1] The disuse of this generic name among Lichens is desirable, inasmuch as it is also applied to a genus of *Protophyta* [*Palmellaceæ*] according to Naegeli. Moreover, there seems no proper ground for separating this and allied pseudo-genera from *Verrucaria*.

tiaca, Lightf. (Körb.); on *L. calcarea* and *Squamaria concolor*, Ram. (apothecia and thallus, *fide* Nyl., Pyren., 64).

Spores ellipsoid, numerous, very minute, 2-locular, brown.

4. *T. stigma*, Körb., Par., 468.

On thallus of *Lecidea* (*Psora*) *lamprophora*, Körb., and *L. geographica*.

Spores 8, 2-locular, brown.

5. *T. Arnoldi*, Hepp; Körb., Par., 469.

Syn. *Abrothallus*, Hepp.
Phœospora, Hepp, 701 and 702.
Microthelia, Hepp; Mass.
Lecidea talcophila, Ach.
Buellia, Körb., Syst., 230.
Sphœria, Hepp; Moug.
Karschia, Körb., Par., 460.

On thallus of *Urceolaria scruposa*, vars. *arenaria*, Schær., *bryophila*, Ach., and *iridata*, Mass.

Spores 8—12, very minute, soleaform (2-locular), brown.

6. *T. grossum*, Körb., Par., 469.

On thallus of *Umbilicaria arctica*.

Spores 6—8, small, soleaform (2-locular), brown. Th. Fries suggests (L. Arct., 165) that this may be *Dothidea Lichenum*, Smrf., which is parasitic on same thallus.

Genus XXXII.—Microthelia, *Körb.* Mudd, 306; Linds., N. Z. Lich. and Fungi, 436.

Species 1. *M. rugulosa*, Borr.

Syn. *Verrucaria*, Borr.; Leight.
Endococcus, Nyl., Prod., 193.
Tichothecium erraticum, Mass. (fide Nyl.).

On thallus of *Lecanora calcarea* and *Squamaria concolor* (Nyl., Prod., 71 and 193). Mudd describes it as having proper thallus.

Spores 8, oblong, 2-locular, dark brown (Mudd): sometimes numerous and ellipsoid (Nyl.).

It is doubtful whether Mudd and Nylander here refer to the same plant. If they do, it is noteworthy that its thecæ are both polyspored and 8-spored, a circumstance that would have great significance in relation to the specific separation from each other of such parasites as *Tichothecium erraticum* and *T. gemmiferum*.

2. *M. calcaricola*, Mudd, 306.

On thallus of *Lecanora calcarea* and *L. gibbosa*, Ach.

Spores 8, ellipsoid-oblong, 2-locular, brown.

3. *M. rimosicola*, Leight., Exs., 253; Mudd, 308.
Syn. *Verrucaria*, Leight., Exs., 253.[1]
Xenosphæria, Körb., Par.
Tichothecium, Arnold.
Phæospora triseptata, Hepp.

On thallus of *Lecidea albo-atra*, v. *epipolia*, Ach. (Mudd); *L. petræa*, v. *concentrica*, Dav.; and other crustaceous Lichens (Körb.).

Spores 8, small, ovoid-oblong, 4-locular, brown.

4. *M. peripherica*, Tayl.; Mudd, 308.

Though described by Mudd as having a proper thallus, is probably parasitic on the sterile thallus of *Lecanora glaucoma* or other crustaceous Lichens.

Spores 8, fusiform, 4-locular, brown. Mudd suggests that it may be a *Sphæria*.

5. *M. verrucosaria* (Mudd, 165).

On thallus of *Lecanora verrucosa*.

Spores 8, ovoid-oblong, 2-locular, colourless. Mudd (who suggests it may be really a *Fungus*) describes it without giving it a name; it is, however, convenient, if not necessary, for future reference, that it should bear some name, and I have therefore placed it provisionally here, regarding the genus *Microthelia*[2] as both a provisional and heterogeneous one.

6. *M. perrugosaria*, Linds., N. Z. Lich. and Fungi, 437.

On apothecia of *Lecanora perrugosa*, Nyl.

Spores oval, 2-locular, brown.

7. *M. Cargilliana*, Linds., N. Z. Lich. and Fungi, 439.

On apothecia of *Parmelia perforata*.

Spores spherical, simple, brown.

8. *M. Ramalinaria*, Linds., N. Z. Lich. and Fungi, 440.

On thallus of *Ramalina calicaris*.

Spores unknown.

9. *M. vermicularia*, Linds., N. Z. Lich. and Fungi, 441.

On thallus of *Thamnolia vermicularis*.

Spores 8, soleaform (2-locular), brown.

10. *M. alcicornaria*, Linds., Spermog.,[3] 161.

On under surface of folioles of horizontal thallus of *Cladonia alcicornis*.

Pycnidia only.

11. *M. prunastria*, Linds., Spermog., 137.

[1] Compare *Verrucaria advenula*, Nyl.

[2] Compare 'N. Z. Lich. and Fungi,' 434; *Fungo-lichenes*, and genus *Microthelia*.

[3] "Memoir on the Spermogonia and Pycnidia of the Higher Lichens;" 'Trans. Royal Society of Edin.,' vol. xxii (1859).

On thallus of *Evernia prunastri*. Körber (Syst., 42) regards it, apparently, as a *Fungus*.

Spores unknown.

12. *M. Solorinaria*, Linds., Spermog., 175.

On thallus of *Solorina crocea*.

Pycnidia only.

13. *M. Collemaria*, Linds., Spermog., 272.

On thallus of *Collema melænum*.

Spores unknown. Perhaps a *Fungus*.

Genus XXXIII.—Phymatopsis, *Tul.* Linds., N. Z. Lich. and Fungi, 442.

Species 1. *P. dubia*, Linds., N. Z. Lich. and Fungi, 442.

a. On apothecia of *Usnea barbata*, v. *florida*.

Pycnidia only.

b. On apothecia and thallus of *U. barbata*, v. *ceratina*.

Spores undetermined.

Genus XXXIV.—Endococcus, *Nyl.*, Nouv. Classif., 193.

Species 1. *E. perpusillus*, Nyl., Prod., 193; Pyren., 64.

On thallus of *Lecanora cinerea* and *Lecidea tenebrosa*.

Spores oblong, 2-locular, brown. Possesses spermogonia.

Nylander places *Microthelia rugulosa*, *Tichothecium gemmiferum*, and *T. erraticum*, with *E. perpusillus*, in his genus *Endococcus* (Pyren., 64). There seems to me no reason for placing these parasites and their co-species in *three different genera!*

Genus XXXV.—Verrucaria.

Species 1. *V. innata*, Nyl. (Flora, 1865).

On thallus of *Lecidea Hookeri*, Schær., but also on earth, associated with *V. nigrata*, Nyl.; both on Ben Lawers (Jones).

2. *V. superposita*, Nyl. (Flora, 1865).

On thallus and hypothallus of *V. theleodes*, Smrf.; occurring also apparently with a proper thallus. Collected by Jones and Carroll, probably in Scotland; but locality not given in Leighton's "Not. Lich.," 'Ann. Nat. Hist.,' 1866.

3. *V. allogena*, Nyl. (Flora, 1865).

On thallus of *Lecidea excentrica*, Ach., Carroll, 1864; but also—apparently with a proper thallus—on rocks on summit of Ben Lawers. Probably only a variety of *V. epidermidis*.

4. *V. endococcoidea*, Nyl. (Flora, 1865).

Syn. *V. advincula*, Nyl.

On thallus of *L. excentrica*, near top of Ben Lawers (Jones); of *Lecidea concentrica*, Dav., near Cork, in my herbarium from Carroll; on *L. petræa* and *L. contigua*, Ben Lawers (Jones, in letter). Frequent in Ireland, always on *L. petræa* or some of its forms (Jones).

5. *V. tartaricola*, Linds. ('Observations on Greenland Lichens').

On thallus of *Lecanora tartarea*, Greenland.

Spores fusiform or oval, 3—5-locular, olive or brown.

6. *V. capnodes*, Nyl. Carroll, "Contributions to British Lichenology," Seeman's Journal of Botany, vol. v, p. 259.

Syn. *V. rhyponta*, Borr. and Leight. (non Ach.).

On thallus of *Graphis sophistica*, Nyl.

Spores 1-septate.

7. *V. advenula*, Nyl. Carroll, "Contrib. Brit. Lich.," Journ. Bot., vol. v, p. 260.

Syn. *V. rimosicola*, Leight.[1]

On thallus of *Lecidea excentrica*.

Genus XXXVI.—Endocarpon, *Hedw.* (pr. p.).

Species 1. *E. microsticticum*, Leight., Exs., 317.

Parasitic on thallus of *Lecanora cervina*, v. *smaragdula* (Leight., in letter to me, 1858). Mudd (159) refers it to the *Lecanora* as a var. *microsticta*, and describes a proper thallus with endocarpoid apothecia, containing spores that are very numerous and minute, ellipsoid, and colourless.

2. *E. Crombii*, Mudd (Brit. Cladoniæ, p. 36).

Parasitic on *Thamnolia vermicularis*.

Sporidia[2] "extremely minute, elliptical, 1-locular, or at times faintly 2-locular, hyaline" (Mudd).

Genus XXXVII.—Pseudographis, *Nyl.*

Syn. *Hysterium*, Pers.
Scleromium Suecicum, Nyl.

[1] Vide *Microthelia rimosicola*.

[2] The terms "*spores*" and "*sporidia*" are in this paper used synonymously. Some lichenologists use exclusively the one term, some the other; while uniformity of practice is most desirable. If the nomenclature of the *Fungi* is to be adopted for parallel organs among *Lichens*—as Berkeley desires should be the case—the term "*sporidia*" is the more correct, and the least likely to lead to confusion or error.

Species 1. *P. elatina*, Ach. (Nyl., Prod., p. 171).

On apothecia of *Lecanora parella* and *Pertusaria communis* (= *Variolaria amara*, Ach.).

Spores colourless or becoming brown, 4—6-locular, sometimes becoming sub-muriform, slightly blue with iodine —an unusual reaction of the spore in Lichens.[1]

Genus XXXVIII.—Arctomia, *Th. Fries.*

Species 1. *A. delicatula*, Th. Fr.

On decayed Lichens in Spitsbergen (L. Spitsb., p. 17). It does not appear whether it is really athalline; or merely, having a proper thallus, overspreads Lichens, as in Scandinavia it does mosses.

Very similar to many of the Micro-lichens recorded in the foregoing enumeration are certain other very minute or microscopic forms, which appear to be athalline or nearly so, but which grow on *Mosses* or *Hepaticæ*, e. g.—

1. *Lecidea contristans*, Nyl. (Flora, 1865; Leight., "Not. Lich.," Ann. Nat. Hist., 1866).

Discovered by Carroll on decaying *Andreæ* on the summit of Ben Lawers (1864).

2. *Verrucaria tristicula*, Nyl. (Flora, 1865; Leight., "Not. Lich.," Ann. Nat. Hist., 1866).

Found by Admiral Jones on *Weissia*, in Aberdeenshire.

3. *V. dubiella*, Nyl. (Flora, 1865).

On mosses, mountains about Loch-na-Cat (Carroll, 1864).

4. *Lecidea Scapanaria*, Carrington, Irish Cryptogams, p. 8.

Syn. *Dactylospora*, Mudd.

Spores 6—8, fusiform, 4-locular, brown.

5. *L. persimilis*, var. *Scapanaria*, Nyl.; Carrington, Irish Crypt., p. 9.

Parasitic on the stems and leaves of *Scapania undulata*, v. *major*, and *S. æquiloba*. Nylander (Scand., 236) describes the type as having a proper thallus.

Spores ellipsoid, 4-locular, brown.

The foregoing list represents—as I have already explained

[1] Nylander ('Prod.,' p. 172) points out that the epispore of *Pyrenula uberina*, Fée, becomes wine-red with iodine, while the endospore remains colourless. I have figured a blue reaction of the epispore in the spores of *Parmelia megaleia*, Nyl., in my "Observations on New Zealand Lichens" ('Trans. Royal Society of Edin.,' vol. xxv, pl. 61, fig. 2 *a*).

—a compilation from those works only to which I have at present access. It could be greatly enlarged by contributions from foreign authors, for the labours of the microscopical school of lichenologists are daily adding to the number of the parasites in question. And I trust in time the list will be so enlarged. Meanwhile it is sufficiently full to illustrate the following points in the Natural History of Lichens:

I. *The difficulties and absurdities of modern Botanical Classification and Nomenclature.*

The majority at least of the genera hereinbefore enumerated may be reduced with propriety to the four following type-genera:—

1. *Verrucaria.*

Verrucaria.	Tichothecium.
Arthopyrenia.	Pharcidia.
Thelocarpon.	Polycoccum.
Thelidium.	Sorothelia.
Microthelia.	Rhagadostoma.
Endococcus.	Spolverinia.
Cercidospora.	Endocarpon.
Xenosphæria.	

2. *Lecidea.*

Lecidea.	Scutula.
Biatorina.	Karschia.
Buellia.	Nesolechia.
Abrothallus.	

3. *Calicium.*

Calicium.	Trachylia.
Sphinctrina.	Acolium.
Stenocybe.	Lahmia.

4. *Arthonia.*

Arthonia.	Leciographa.[1]
Opegrapha.	Celidium.
Pseudographis.	Phacopsis.
Placographa.	Phymatopsis

[1] Stizenberger apparently arranges it under *Buellia* ('Beit. z. Flecht.,' 161).

There is a most unnecessary *sectioning* of genera, according: usually, to the simplicity or complexity of the *spore*. Were the structure of the spore *constant* it might be made a very convenient basis for dividing genera into *sections*, but certainly not for splitting genera like *Lecidea* into a host of independent *genera*. The character of the spore is *not*, however, constant, even in the same species; it is, *e. g.*, frequently, even in the same plant, simple, or 2- or more-locular: in which case a given Lichen, such as *Lecidea vernalis* or *anomala*, is artificially referred to one genus, while it belongs, in another sense, at least to two, and perhaps to more!

The most anomalous genera in the preceding list are *Celidium*, *Phacopsis*, and *Phymatopsis*, which are really intermediate in characters between the *Lecideæ* and *Graphideæ*. But they may with propriety, I think, be referred provisionally to *Arthonia*, so long as that genus is the very heterogeneous one it is, and includes so many Lecidioid forms like *A. melaspermella*.[1]

The most diverse views are frequently adopted by different observers as to the character of the same Lichen and its place in classification. Moreover, the opinions of the same author are constantly undergoing variation. Hence it follows that the most extraordinary changes occur in the nomenclature of the same plant, with a corresponding confusion of synonymy. The changes and confusion in question, relating both to genera and species, are represented especially by the following species: and this confusion would be much more apparent if I had access to *all* the published contributions of continental authors on the group of parasites now under review:—

Lecidea parasitica, micraspis, sagedioides.
Tichothecium gemmiferum, pygmæum, Arnoldi.
Microthelia rugulosa, rimosicola.[2]
Abrothallus Smithii, oxysporus.
Arthonia varians.
Sphinctrina turbinata.
Acolium corallinum.
Xenosphæria Engeliana.
Karschia talcophila.
Scutula Wallrothii.

[1] *Vide* author's paper on *A. melaspermella*, 'Journ. Linn. Soc.,' "Botany," vol. ix, p. 274; and 'N. Z. Lich. & Fung.,' 449, 450. Stizenberger apparently arranges *Phacopsis* under *Lecidea* ('Beitr. z. Syst.,' 162).

[2] I am utterly at a loss to understand on what grounds Nylander alters the name of this well-known Lichen to *Verrucaria advenula!* (q. v.)

Celidium Stictarum.
Conida clemens.
Phacopsis psoromoides.

This complexity of synonymy illustrates the rage of the present continental school of lichenologists (the German, Italian, and Scandinavian) for the multiplication of genera and species, and of names. It indicates, I think, a serious defect in classification and nomenclature—one that will probably not be corrected till the whole group of parasitic Micro-lichens is studied by some experienced lichenologist, who is more a *biologist* than a *species-monger*, imbued, as he should be for such a task, with philosophical conceptions of the constitution of genera and species.

II. *The confusion between Lichens and Fungi.*[1]

This subject has already been partly illustrated in the introduction to this paper,[2] and it will be further discussed in a subsequent paper on the *Micro-Fungi* that are parasitic on Lichens—a paper that will form a natural complement to the present. Not a few of the Lichens enumerated above have already been referred by various authors to the *Fungi*, e. g. to the genus—

1. Sphæria: — *Celidium Stictarum; Conida clemens; Sphinctrina turbinata; Xenosphæria Engeliana; Tichothecium gemmiferum; T. Arnoldi.*
2. Peziza:—*Scutula Wallrothii; Leciographa Neesii.*
3. Dothidea:—*Celidium Stictarum.*
4. Sclerococcum:—*Acolium corallinum.*

While several others will probably ultimately be regarded as *Fungi*, e. g.—

Lecidea obscuroides, Alectoriæ, Cladoniaria, associata.
Abrothallus Usneæ.
Celidium fusco-purpureum, Stictarum, varium, dubium, Pelvetii, &c.
Phacopsis vulpina, psoromoides.
Microthelia perrugosaria, Cargilliana, verrucosaria, Ramalinaria, vermicularia, alcicornaria, prunastria, Solorinaria, Collemaria, &c.
Phymatopsis dubia.
Karschia Strickeri.

[1] Compare also what I have said on this subject in the following papers:
1. "*Arthonia melaspermella*:" 'Journal of Linnean Society,' "Botany," vol. ix, p. 269.
2. 'N. Z. Lich. and Fungi,' p. 434.
3. 'Polymorphism in Lichens.'

[2] 'Quart. Journ. of Mic. Science,' Jan., 1869.

III. *The same host (Lichen-thallus) frequently bears more than one Parasite.*

This assertion will be further borne out when my list of *Micro-Fungi* parasitic on Lichens is published. Meanwhile the subjoined list will illustrate the frequency with which *Micro-Lichens* occur on the thallus of higher species. On—

STICTA SYLVATICA, S. FULIGINOSA } *Abrothallus Smithii; A. Welwitzschii.*

PARMELIA SINUOSA, P. CONSPERSA } *A. Smithii; A. oxysporus.*

PARMELIA SAXATILIS:—*Abrothallus Smithii; A. oxysporus; Sphinctrina turbinata; Lecidea Egedeana.*

P. CAPERATA:—*A. Smithii; A. microspermus; A. oxysporus; Nesolechia thallicola.*

P. PERFORATA:—*Abrothallus Curreyi; Microthelia Cargilliana.*

PHYSICA PARIETINA:—*Lecidea glaucomaria; Celidium varium; Arthonia varians.*

P. PULVERULENTA:—*Karschia pulverulenta; Abrothallus Smithii.*

P. OBSCURA:—*Lecidea obscuroides; Buellia convexa.*

CETRARIA GLAUCA:—*Abrothallus Smithii; A. oxysporus.*

C. ISLANDICA:—*Abrothallus Smithii; Lecidea Cetraricola.*

PELTIDEA CANINA:—*Celidium fusco-purpureum; Scutula Wallrothii.*

SOLORINA CROCEA:—*Biatorina tuberculosa; Rhagadostoma corrugatum; Microthelia Solorinaria.*

S. SACCATA:—*Scutula Krempelhuberi; Xenosphæria Engeliana.*

USNEA BARBATA:—*Abrothallus Usneæ; A. Smithii; Phymatopsis dubia.*

EVERNIA PRUNASTRI:—*Abrothallus Smithii; Microthelia prunastria.*

STEREOCAULON TOMENTOSUM:—*Biatorina Stereocaulorum; Scutula Stereocaulorum; Ephebe pubescens.*

BÆOMYCES RUFUS:—*Nesolechia ericetorum; Thelocarpon epithallinum; Lecidea parasitica, scabrosa, inquinans, arenicola.*

B. PLACOPHYLLUS:—*Lecidea scabrosa; Lahmia Fuistingii.*

Squamaria saxicola:—*Lecidea micraspis; Conida clemens; Cercidospora Ulothii; Thelidium epipolytropum.*

S. concolor:—*Tichothecium erraticum; Microthelia rugulosa.*

Placodium albescens:—*Conida clemens; Tichothecium pygmæum.*

Thelotrema lepadinum:—*Nesolechia Nitschkii; Stenocybe eusporum.*

Pertusaria communis:—*Lecidea parasitica; Sphinctrina turbinata* and v. *microcephala; Trachylia stigonella; Pseudographis elatina; Opegrapha anomea.*

P. Wulfenii:—*Lecidea parasitica; Sphinctrina turbinata* and var. *microcephala; Trachylia stigonella.*

P. ocellata—*Lecidea micraspis; Acolium corallinum.*

Urceolaria scruposa:—*Karschia talcophila; Tichothecium Arnoldi.*

Phlyctis argena:—*Sorothelia confluens; Leciographa Neesii.*

Lecanora calcarea:—*Lecidea episema; L. micraspis; L. parasitica; Opegrapha Monspeliensis; Arthonia Aspiciliæ; Leciographa Neesii; Thelidium aggregatum; Tichothecium pygmæum; T. erraticum; Microthelia rugulosa; M. calcaricola.*

L. cinerea:—*Endococcus perpusillus; Tichothecium gemmiferum; Lecidea episema.*[1]

L. tartarea:—*Lecidea associata; L. parasitica; Verrucaria tartaricola.*

Lecanora parella:—*Pseudographis elatina; Lecidea parasitica.*

L. glaucoma:—*Arthonia varians; Celidium furfuraceum; Acolium corallinum.*

L. polytropa:—*Cercidospora Ulothii; Thelidium epipolytropum; Tichothecium pygmæum.*

L. subfusca:—*Lecidea parasitica; Arthonia varians; Pharcidia congesta.*

Lecidea contigua:—*Tichothecium pyymæum; T. gemmiferum; Verrucaria endococcoidea.*

L. sabuletorum } *Tichothecium gemmiferum; T. pyg-*
L. fusco-atra } *mæum.*

L. parasema:—*Tichothecium gemmiferum; Arthonia varians.*

[1] Carroll, "Contrib. Brit. Lich.," 'Journ. Botany,' vol. v, p. 257.

L. GEOGRAPHICA:—*Tichothecium stigma; T. pygmæum.*

L. ALBO-ATRA:—*Microthelia rimosicola; Arthonia punctella.*

L. EXCENTRICA:—*Verrucaria allogena; V. endococcoidea; V. advenula.*

L. PETRÆA:—*Microthelia rimosicola; Celidium furfuraceum; Verrucaria endococcoidea.*

ISIDIUM CORALLINUM, Ach.:—*Arthonia varians; A. punctella; Acolium corallinum.*

On the other hand, it will be observed that—

IV. *The same parasite frequently affects a considerable number of Lichens of different genera.*

And this is a fact likely to be more firmly established in proportion as our knowledge of the Micro-parasites on Lichens becomes extended and improved. The best illustrations of frequent occurrence on the thallus of different genera are to be found in the following parasites:—

Tichothecium pygmæum; T. gemmiferum.
Abrothallus Smithii; A. oxysporus.
Sphinctrina turbinata.
Arthonia varians.
Celidium Stictarum.
Buellia urceolata.
Lecidea parasitica.

On some TECHNICAL APPLICATIONS *of the* SPECTRUM MICROSCOPE. By H. C. SORBY, F.R.S., &c.

CONTENTS:—Introduction, p. 358—On the Colouring Matters of Wines, p. 360—On the Age of Dark Wines, p. 363—On White Wines, p. 367—Adulterations of Wine, p. 368—On the Colouring Matters in Malt Liquors, p. 370—Adulterations of Malt Liquors, p. 373—Adulterations of Mustard, p. 377—Adulterations of Rhubarb, p. 378—Adulterations of Cheese, p. 379—Adulterations of Butter, p. 380—Adulterations of Saffron, 381—Adulterations of Aloes, p. 382—Adulterations by means of Cochineal and Magenta, p. 382.

MY object in publishing the following paper is to show that the spectrum microscope may be applied with advantage in several departments of technical inquiry, and more especially to describe the methods useful in such investigations. Since these will be much more readily understood by means of practical illustrations, I shall not make many general

introductory remarks, but reserve an account of each particular process until I come to those practical questions which require its adoption.

In the first place, I beg to refer to my papers "On a Definite Method of Qualitative Analysis of Animal and Vegetable Colouring Matters,"[1] and "On the Colouring Matters of Blue Decayed Wood,"[2] since much that I shall describe will be a continuation and application of what they contain. I shall make use of the same scale for measuring the position of the absorption bands, and the same notation and symbols to express the varying power of absorption in different parts. This scale is an interference spectrum with dark bands, which divide the whole visible spectrum into twelve portions of equal optical value; and it is so adjusted that the sodium line D is situated exactly at $3\frac{1}{2}$. On this scale the principal Fraunhofer lines occur as follows:

A ... $\frac{3}{4}$	B ... $1\frac{1}{2}$	C ... $2\frac{3}{8}$	D ... $3\frac{1}{2}$
E ... $5\frac{11}{16}$	*b* ... $6\frac{3}{16}$	F ... $7\frac{1}{2}$	G ... $10\frac{3}{8}$

The only objection to this scale is that its accuracy is dependent on the careful preparation of the plate of quartz. I have myself made several perfectly alike and accurate, and nothing but proper care is required. When once accurately made, no scale could be more convenient, since the bands occur at equal optical intervals over the whole spectrum, and are quite distinct when the slit is opened rather wide, which is sometimes a great advantage. In these two respects it is far superior to any other scale hitherto proposed.

The intensity of absorption will be expressed by means of dots, hyphens, and dashes; thus:

Not at all shaded		Blank space.
Very slightly shaded	.	Single dot.
Slightly shaded	..	Double dots.
Moderately dark	--	Double hyphens.
Very dark	—	Single dash.

When these symbols are printed *between* numbers they signify that there is a more or less strong absorption between those points of the spectrum as measured by the above-named scale; whereas when they are printed *under* numbers they signify that there is a distinct absorption band, of the intensity expressed by the different symbols, the *centre* of which is situated at that point of the scale indicated by the figures. This latter method is extremely simple and convenient, and often serves to express all that is requisite. It

[1] 'Proceedings of the Royal Society,' 1867, vol. xv, p. 432.

[2] 'Quarterly Journal of Microscopical Science,' January, 1869.

may, perhaps, appear imperfect to those accustomed to the study of the spectra of substances in the state of incandescence, but it is in all respects well adapted for the study of the spectra of solutions, in which a slight difference in the character of the solvent often makes far more difference in the position of the bands than any that could result from errors due to the employment of such a scale and notation. To hold the liquids under examination, I in most cases employ narrow, deep cells, usually one eighth of an inch diameter, and half an inch deep, so mounted that they can be examined either in the line of the length or at the side; but occasionally I use rather wider, as much as two and a half inches long.

By using these narrow cells very much less material is required for successful examination, which is not only most important when very little is at command, but even in other cases often effects a considerable saving of time in filtration and evaporation.

I shall divide my subject into three principal heads, viz.: 1. Various facts connected with wine; 2. Those relating to malt liquors; and—3. Such as illustrate the methods that may be employed to detect adulteration in various substances used as food or medicine.

1. *On the Colouring Matters of Wines.*

The pure colour of fresh dark grapes is best prepared by removing the skins, heating them in alcohol, evaporating the solution to dryness, redissolving it in a little water, filtering, and again evaporating to dryness in a small saucer, in which the colour may be kept as a stiff syrup for many months without material change. It belongs to the group of colours which I called group B in my paper in the 'Proceedings of the Royal Society'—that is to say, sulphite of soda produces no immediate effect when added to a solution rendered alkaline by ammonia; but when added to one made acid with citric acid, it almost immediately removes the detached absorption in the green, so that the solution becomes very pale.

Since this colour of dark grapes is purple when dry and quite neutral, it may be called *Vitis purple*. I have not yet met with it in any other fruit, unless it be in that of the common crowberry (*Empetrum nigrum*). One of its peculiarities is that it easily passes into insoluble modifications. It belongs to my sub-group B $al_o am_o$, since it does not give any decided narrow absorption band in an alcoholic solution, when either neutral or with excess of ammonia. Such

colours are amongst the most difficult to distinguish from one another, and I have not yet been able to discover any more satisfactory method than the following:—A slight excess of ammonia should be added to the alcoholic solution; made so dilute that the absorption in the orange part of the spectrum is distinct, but yet very far from black, and the position of the limit of the absorption towards the red end carefully measured and recorded, thus—1$\frac{5}{8}$ . . . .

The same limit should also be ascertained after considerable excess of hydrochloric acid has been added to the solution, both in water and in alcohol; which solutions sometimes give the same, but sometimes materially different, spectra. These various limits of absorption vary with the depth of colour, but by taking care to have solutions which give equally strong absorptions, and comparing them side by side, it is often very easy to distinguish from one another very closely allied colours—for example, that of dark gooseberries from that of grapes, or that of fresh grapes from that of new dark wines. The difference between these latter is proved, not only by the spectra, but also by other facts.

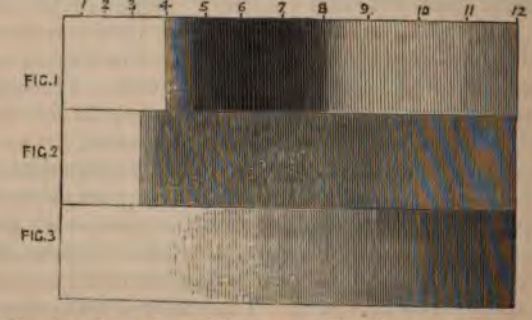
In my paper in the 'Proceedings of the Royal Society,' already cited (p. 443), I showed that when certain colouring matters are dissolved in water or alcohol, they give deep-coloured solutions, which rapidly fade to nearly colourless; but when these faded solutions are evaporated to dryness, the colour is completely restored to its original state, and is also made quite as dark as if it had never faded, by adding some strong acid; so that the fading is not due to decomposition, but to a molecular change rapidly taking place in dilute solutions. The colour of fresh grapes is an example of this; and by comparing with a standard which did not fade, the solution immediately after the colour was dissolved, and the same after less than an hour, when no further change occurred by keeping it longer, I found that the faded required fully five times the thickness to give the same intensity of absorption at the yellow end of the green. On the contrary, new dark wines evaporated to dryness do not fade at all in such a manner when redissolved in water.

This colour of new wines appears to be produced at a very early part of their formation. By dissolving the colour of the fresh grapes in the juice, adding a little yeast, and keeping the solution warm for a few days, the colour appeared to be changed into that found in new wines, and did not fade at all when redissolved in water. The colour kept as dry syrup for three years showed a similar change. I think it must be, therefore, due either to fermentation or to a slight oxidiza-

tion. I am much inclined to adopt the latter explanation, for if citric acid be added to an aqueous solution of the fresh colour, and then a small quantity of hypochlorite of soda, the colour is changed from pink to pink-red, the absorption is found to extend more towards the red end, and to be more uniform over the green and blue; in all which particulars it corresponds with the spectrum of new wine. No such change occurs when the wine is treated in the same manner, as though this alteration had already taken place. Both these colours belong to my group B; but when either is still further oxidized by means of rather more hypochlorite of soda, a sort of orange colour is produced, which seems to correspond with that of port-wine kept for twenty years or more in the cask; and when still further changed, it becomes quite pale, like very old wines. The following table will show these facts more clearly:

Colour of dark grapes in citric acid and water,	4 ..	$4\frac{1}{2}$ -- $8\frac{1}{2}$ ..	11 --
Ditto, after adding a little hypochlorite of soda,	$3\frac{1}{4}$ ..	$3\frac{3}{4}$ ----	
New natural port wine	$3\frac{1}{4}$ ..	$3\frac{3}{4}$ - - -	
Ditto, after adding a little hypochlorate of soda,	$3\frac{1}{4}$ ..	$3\frac{3}{4}$ - - -	
Colour of dark grapes with more hypochlorite of soda	.5 ..	6 - -	10 —
New natural port wine with ditto	.5 ..	6 - -	10 —
1834 port from the cask	.5 ..	6 - -	10 —

Since this change in the spectrum depending on the state of oxidization is of considerable interest as illustrating a general law, I here subjoin a woodcut, in order to render my meaning more intelligible to those not accustomed to the use of the symbols employed in the above table. Fig. 1 shows the spectrum of the colour of dark grapes in its natural state, in citric acid and water. Fig. 2 is the spectrum of the oxidized modification met with in new wines: and fig. 3 that of the



per-oxidized colour found in very old wines, or formed by the more complete artificial oxidization of the other two.

This colour of very old wine belongs to my group C, and is not changed by adding sulphite of soda to an acid solution; whereas, as already mentioned, the characteristic colour of very new wine belongs to my group B, and if it could be obtained in a pure state, would probably become nearly colourless on the addition of the sulphite. This difference between the colour of new and old wine has enabled me to contrive a method by means of which I can ascertain the approximate age of port wine kept in the cask. In these experiments I have been very much assisted by my friends, Mr. Joseph Prestwich, F.R.S., and Mr. Alexander Hay, of Sheffield, who have most kindly supplied me with the requisite samples.

On the Age of Dark Wines.

In order to obtain good results considerable care is required, and after trying several methods I found the most satisfactory was as follows:—I have two experiment cells one inch long, made from stout tube, having an internal diameter of about a quarter of an inch. Both ends are cut square, and one is fastened to a piece of glass like a microscopical object by means of purified gutta percha. This I find a most valuable cement for such purposes, since it resists the action of alcohol, acids, and alkalis. The glass must be heated until the gutta percha is sufficiently soft. One of the tubes is carefully graduated into ten equal parts, and the other left plain. Wine in its natural state is often much too dark coloured to enable us to recognise the effect produced by adding sulphite of soda, when we examine the spectrum of the thickness of one inch. It is, therefore, requisite to dilute it with so much of a mixture of one part of alcohol with three of water that the spectrum of the light which has passed through the experiment cells may show a strong, but by no means complete absorption of the light in the yellow and in the yellow end of the green. After diluting some of the wine to this extent, and adding so much citric acid that it may have a very strong acid reaction, it should be poured into two test tubes, powdered sulphite of soda dissolved in one, and the other kept without. Though the sulphite may produce a very considerable change at once, the alteration is not complete for a while, and therefore it is best to keep the solutions for an hour or two in the tubes, corked up to prevent evaporation. The point to be then determined is, how much less thickness of the diluted wine to which no sulphite has been added will give exactly the same intensity of absorption in the yellow, and in the yellow end of the green, as the thickness of one inch of the

same acted on by the sulphite of soda. The ungraduated tube should, therefore, be filled with the latter, and a small piece of thin glass placed on the top, so that the light may pass through exactly one inch in thickness of the liquid, and none run out when the tube is placed in an inclined position on the side stage of the spectrum eye-piece. The diluted wine should then be introduced into the graduated tube, which is placed nearly vertically on the ordinary stage of the microscope, and the depth of the liquid carefully regulated by means of a pipette, so that the intensity of the absorption in the two spectra may be exactly the same in the yellow and in the yellow end of the green. The light must be of the same intensity in both spectra, and therefore it is also particularly necessary so to regulate the instrument that the transmitted red rays may be of exactly the same brilliancy. The accuracy of this experiment is limited by the difficulty of recognising when the transmitted and the absorbed rays are equal in both spectra, and by its being difficult to determine the depth of the diluted wine to less than $\frac{1}{100}$ of an inch. The actual value of the measurements varies to some extent, according to the manner in which the experiments are made, and therefore I strongly advise any one who may wish to employ this method to prepare for himself a table of the comparative amount of change of wines of various ages.

When sulphite of soda is added to a faded solution of the colouring matter of fresh dark grapes it is changed to a pale orange yellow, which colour is, I believe, due in great measure to the presence of the same yellow substance as is met with in green grapes, so that the intensity of absorption is reduced to about $\frac{1}{10}$, or from 1·00 to ·10. In the case of the perfectly new wine prepared by myself, the intensity of absorption was reduced from 1·00 to about ·22. My experiments with the wines of commerce were chiefly made in April, 1868. The newest port wine that I was able to examine was of the vintage of 1866, and therefore about one year and a half old, and even this contained a good deal of the C colour. I examined several specimens of the same vintages of various older dates, which differed considerably in general colour and character, but when all had been kept for the same time in the casks I did not find any material difference in the general results. From the manner in which the experiments were made, the change produced by adding the sulphite of soda is referred to the amount of the C colour taken as unity; and, assuming that the extent to which the wine has been altered by keeping is the difference between the amount still unchanged and unity, the numbers given indicate the relative changes

produced by the slow action of the air, but they can only be looked upon as expressing the rate of one particular kind of change. The following table has been constructed from the whole of my observations, so as to give a good general illustration of the subject.

Column 1 shows the age of the wine in years and the date of the vintage.

Column 2 gives the thickness of the diluted wine without sulphite, which produced the same intensity of absorption as 1·00 inch of that to which the sulphite had been added.

Column 3 shows the difference between the values in column 2, divided by the number of years between each two, so as to exhibit the amount of change for each year, after the wine had been kept for the various periods:—

I.		II.	III.
0	(Made by myself) . .	·22	
		. . . .	·2700
1½	(1866) . .	·63	
		. . . .	·0700
2½	(1865) . .	·70	
		. . . .	·0300
3½	(1864) . .	·73	
		. . . .	·0200
4½	(1863) . .	·75	
		. . . .	·0150
5½	(1862) . .	·76½	
		. . . .	·0150
6½	(1861) . .	·78	
		. . . .	·0070
9½	(1858) . .	·80	
		. . . .	·0030
16½	(1851) . .	·82	
		. . . .	·0020
20½	(1847) . .	·83	
		. . . .	·0008
33½	(1834) . .	·84	
		. . . .	·0007
47½	(1820) . .	·85	

Since the above table does not refer to wines of even years of age, I subjoin below another derived from it by laying down the results on paper as a curve, and interpolating by careful measurements:—

I.	II.	III.
0	·22	
		·330
1	·55	
		·120
2	·67	
		·050
3	·72	
		·022
4	·742	
		·017
5	·76	
		·012
6	·772	
		·010
7	·782	
		·007
8	·79	
		·005
9	·795	
		·005
10	·80	

It will thus be seen that the rate at which the B colour changes into C is far more rapid in the case of new wine, when much of it is present, than after the wine has become older; being, in fact, about ten times as rapid in the first year as in the third, and about 100 times as rapid as in the twentieth. On this account the difference for each year is at first so considerable that wines of different vintages could easily be distinguished; but after about six years the difference is so small that it would be difficult, or impossible, to determine the age to within a single year. After twenty years a difference of even ten years does not show any striking contrast, and the age could not, therefore, be determined to nearer than ten years by this process. However, up to six years I think it quite possible to determine the age to within a single year. I took specimens of various ports from the casks, of different ages up to six or seven years, and labelled them in such a manner that I did not know the age of any, but could ascertain it afterwards by reference. I then made the experiments with great care, and found that by proper attention to the details described above I could correctly determine the year of vintage of each particular specimen.

As already mentioned, the change of the B colour into the C is most probably the effect of the oxygen of the air, which appears to act slowly through the wood of the cask; but the relative amount of these two colours is also modified by the deposit of crust. When kept in well-corked bottles the change does not appear to be the same, and goes on far more

slowly. I therefore think it would be scarcely possible to ascertain the length of time that the wine had been in bottles, and am inclined to believe that the amount of change observed on adding sulphite of soda corresponds more closely with the time that the wine had been previously kept in the cask. I have especially observed this in the case of Bordeaux and Burgundy wines. Those of this type which I have hitherto examined seem to contain a larger relative amount of the B colour, when a few years old, than ordinary ports, and in this respect agree with the so-called *natural port;* but the rate of change is greater when they are kept for some years, probably owing to their containing a less amount of alcohol. There is also a greater variation in different samples of the same age than I have met with in port wine, which is probably because the amount of alcohol in such wines varies more in proportion to the total quantity.

It appears, therefore, that the natural colour of dark grapes is changed by oxidization into the somewhat similar colour found in new wines, and that by still further oxidization this is converted into another entirely different colour, which becomes much paler by further oxidization. The rate at which these changes take place varies according to circumstances, but, other things being equal, it varies according to the time of the action. Much also depends on the deposition of colour in the form of crust, and after a long time the original dark coloured substance is almost entirely lost, and only an amber colour remains in solution, which behaves with reagents precisely like that in sherry wines.

On White Wines.

The colouring matter of white wines appears to be derived from one of those yellow substances, soluble in water, of which there are several of materially different character in the faded leaves of different kinds of plants, as more fully described below when treating on hops. That met with in the orange-coloured leaves of the beech is a good example. The depth of the colour is made nearly ten times as great by the addition of ammonia, and when dissolved in strong sulphuric acid diluted with an equal bulk of water, oxidizing reagents first turn it much darker, and then much paler. When, however, kept for some months dissolved in dilute alcohol it turns to a much darker tint, and then the solution, with excess of ammonia, is only twice as dark as when made acid by citric acid. Oxidizing reagents added to the solution in sulphuric acid do not make the tint any deeper, and thus it appears as if it had been changed by oxidization into an

entirely different colour. The character of this change agrees with what occurs when the colour of dark grapes is oxidized, as already described; and both are good examples of what appears to be a general law. If not already oxidized, a certain amount of oxidization causes the absorption to advance towards the red end of the spectrum to an extent varying according to the position of the original absorption, and then a still further oxidization causes the absorption to recede from the red end to considerably beyond the original position, sometimes so much so that all colour is lost. We might thus say that such substances may occur in an unoxidized, in an oxidized, and in a per-oxidized condition. These and similar facts seem also to show that there is an intimate relation between the chemical changes and the particular rays of light absorbed by such substances; but the discussion of this very interesting question would lead me far away from the more immediate subject of this paper.

On comparing the colour of sherry wine with that produced by the action of the air on a solution in dilute alcohol of the substance in faded beech leaves soluble in water, I was unable to discover any difference, and hence I think we may conclude that it is formed by the oxidization of the yellow colour of the grapes; but in some wines it is imperfectly oxidized, and they turn darker when exposed to the air.

Adulterations of Wine.

The only cases in which the spectrum method can be easily applied to detect adulterations in wines are when some colouring matter has been introduced to give a false appearance of age, or to bring the colour up to some desired standard. According to Payen's interesting work,[1] logwood and Brazil wood were at all events employed a few years ago for this purpose; and rhatany root and the berries of the so-called *Virginian Poke* (*Phytolacca decandra*) are sometimes used. I mention these because I purpose to briefly describe how they may be detected, as an illustration of the methods which may be employed in such investigations. I must, however, confess that I have not detected these substances in any wines of commerce that I have yet examined; but then I have had very little opportunity for studying those likely to contain them.

In order to detect logwood or Brazil wood, a small quantity of the wine should be agitated in a test-tube with an equal volume of ether, which rises to the surface in an almost colourless state if the wine be pure, but is tinged with a more

[1] 'Précis des Substances Alimentaires,' note at p. 455.

or less strong yellow, when either of the above-named substances is present. The etherial solution should be transferred to a small evaporating dish by means of a pipette, and a fresh quantity of ether agitated with the wine, and added to the other. The most useful kind of pipette for this and similar purposes is one with a small vulcanized india-rubber top, so arranged that, after having been compressed, it may by its own elastic force draw up the liquid. After evaporating the solution to dryness, a small quantity of the colour should be dissolved in water in an experiment-cell, and treated with bicarbonate of ammonia. In both cases this develops a single very distinct absorption-band in the green, that characteristic of logwood being situated at $4\frac{3}{8}$ of my scale, whilst that of Brazil wood is farther from the red end, at $5\frac{1}{4}$; and the solution is strongly fluorescent, of a peculiar orange colour. These spectra are so characteristic, and can be so easily compared with those of the substances themselves, that an extremely minute quantity of either could be detected with certainty.

The colour of rhatany root does not give any well-marked band in an aqueous solution, either acid or alkaline; but when dissolved in alcohol and slightly acid, it shows a moderately distinct band between the yellow and green, at $3\frac{3}{4}$ of my scale, and a fainter at $7\frac{1}{4}$. In order to detect this substance the wine should, therefore, be evaporated to small bulk, and redissolved in strong alcohol, and after this has stood in a test-tube until the insoluble matter has been deposited and the solution has become quite clear, the absorption-band at $3\frac{3}{4}$ may be more or less distinctly recognised, according to the amount of the rhatany root present; but the natural colour of the wine makes it impossible to detect a very small quantity.

The dark crimson berries of the Virginian poke are remarkable for containing a colour belonging to my group C; whereas those of nearly all fruits of that tint belong to group B. It shows two absorption-bands, which are more distinct in an alcoholic than in an aqueous solution, and are $4\frac{5}{8}$, $7\frac{5}{8}$. To detect this substance we ought, therefore, to adopt the same process as in the case of rhatany root, and endeavour to see those bands, which might sometimes be made more distinct by adding a little water and sulphite of soda.

These substances may be changed by keeping long in solution, and therefore might not be detected in old wines.

On the application of the Spectrum-microscope to the Chemistry of Beer.

In studying the colouring matters in beer it is, in the first place, desirable to understand those met with in the various substances used in brewing; but it is unnecessary to take into consideration colours insoluble in water.

When malt is digested in hot water an orange-yellow colouring matter is extracted, but the solution contains so much sugar and gum as to interfere with the necessary experiments. It should, therefore, be evaporated to the consistency of syrup, alcohol added by degrees, and the precipitated gum and sugar well stirred up, so that as much colouring matter as possible may be dissolved. After standing till quite clear this solution on evaporation yields a pale orange-yellow syrup, which when dissolved in water or alcohol gives a spectrum without any decided characters. Ammonia makes it a deeper and brighter yellow, and the same change occurs when it is dissolved in sulphuric acid. In all these experiments a mixture of equal volumes of the concentrated acid and water should be used, for if much stronger it chars vegetable substances, and if weaker it does not act well with the reagents added to it. When dissolved in this the colour of malt is made much darker by the addition of nitric acid or chlorate of potash, but an excess of the latter makes it rapidly fade to a pale yellow; whilst hypochlorite of soda in small quantity makes it somewhat more orange, and more makes it a very pale yellow. The characteristic test is hypochlorite of soda, added to an aqueous or alcoholic solution, in which a little citric acid has been dissolved. The addition of a suitable quantity of the hypochlorite turns the aqueous solution to a pink flesh-colour, becoming deeper; but it is not clear, and on standing a copious pink flocculent deposit subsides. When seen to the greatest advantage, the spectrum is 4.--8..10--11—, without any decided narrow absorption-bands. If, however, the colour was dissolved in alcohol, the solution remains clear; there is a well-marked band at the yellow end of the green, which at first is $4\frac{3}{4}$, and, as the colour becomes deeper, is more distinct, and rises to 5. The flesh-coloured deposit from the solution in water is easily dissolved by alcohol, and gives the same spectrum; and these facts are so unique that this colouring matter could be easily recognised in complicated mixtures. It certainly does not occur in barley, and must, therefore, be formed in the process of malting. Water extracts from barley a brown colour

insoluble in alcohol, which exactly corresponds with that of liquorice; and also a yellow colour soluble in spirit, which does not exactly correspond with that obtained from hops, but yet differs from it in such a manner that, taking all the facts into consideration, it seems probable that it is the same colour in a less pure condition.

When hops are boiled in water, the solution evaporated, and the gum, &c., removed by alcohol, as already described, an orange-yellow colour is obtained, which in general appearance and in its behaviour with most reagents is extremely similar to that from malt. It may, however, be easily distinguished by the action of hypochlorite of soda, for when this is added to an aqueous solution previously treated with a little citric acid, it merely changes it to a very pale yellow, without any shade of pink. This colour, or at least colours, which I have not been able to distinguish from it, is met with in several kinds of faded leaves, stems, and roots, and seems to be very generally distributed.

When the partially charred malt used in brewing porter is digested in water, a dark solution is obtained, and on evaporation to small bulk and treatment with alcohol nearly the whole of this dark colour is precipitated along with the gum. To obtain it more pure it may be redissolved once or twice in a little water, and reprecipitated by alcohol. When dissolved in water it gives an orange-brown solution, with a spectrum . . . 4 .. 5 - - 6—, made somewhat darker by ammonia; and when dissolved in sulphuric acid the colour and spectrum are nearly the same. Oxidizing reagents do not make it any darker in either solvent, but merely cause it to fade to a pale yellow.

Besides this dark colour, highly dried malt contains an orange yellow, soluble in both strong alcohol and water. This differs from that obtained from pale malt in not being turned at all pink by the action of hypochlorite of soda, and is distinguished from the colouring matter of hops or of beer, with which it agrees in general colour, by not being made at all darker by the addition of oxidizing reagents to the solution in sulphuric acid, as if it were already in an oxidized condition.

Liquorice is chiefly coloured by a brown substance, which closely resembles that present in dark malt. When alcohol is added to the strong aqueous solution it is precipitated in the same manner; and when dissolved in water the general colour is very similar, though rather more orange. They may, however, be easily distinguished by the action of oxidizing reagents. If to solutions in sulphuric acid of

equal depth of colour equal quantities of chlorate of potash be gradually added, the malt first becomes a much paler orange, and then pale yellow; whereas the liquorice turns to an orange, which does not become pale until very much more chlorate has been added than suffices to make the malt very pale. Though they can thus be easily distinguished, yet when mixed together, as in porter, it is not easy to obtain decided results. The change of colour is very similar in kind, and differs only in degree; so that the addition of too much chlorate may make the liquorice as pale an orange as the malt; and when not much liquorice occurs mixed with malt, it becomes very difficult to recognise it. Still, however, with care its presence may be detected in ordinary porter.

That colouring matter of porter which is soluble in strong alcohol behaves with reagents like a mixture of those from beer and dark malt. Hypochlorite of soda turns the solution in sulphuric acid to a red, but of a less deep tint than in the case of beer.

The sweet wort obtained in brewing contains the colour of malt, already described, and, after boiling with hops, the hop colour; but after fermentation a change is found to have occurred, which proceeds still further when the beer is kept in the barrel. This change is best shown by the addition of hypochlorite of soda to the solution of the colouring matter in sulphuric acid. The gum, &c., should be removed by means of alcohol, in the manner already named when describing malt. Taking two experiment-cells, and dissolving in one the colour of the unfermented wort, and in the other an equal quantity of the colour of beer that has been kept some months in barrel, the general tint is seen to be very similar. Since the solutions are otherwise apt to be turbid, it is best to fill the tubes three fourths with the sulphuric acid diluted with an equal bulk of water, and then to fill up with alcohol, after which the coloured syrup can be added on a platinum wire, and made to dissolve by stirring. On adding little by little hypochlorite of soda to such a solution of the unfermented wort, it first turns it a little more orange, and then pale yellow; whereas, in the case of the beer kept in barrel, it is first gradually changed to a deep pink-red, which, when strong, is 3 . - 4—, and when seen to the greatest advantage is 5 - - 7½ ... 9½ - - 10—, having, therefore, a broad absorption-band at 6¼. On adding more hypochlorite it becomes more orange, and finally an orange-yellow. The fermented wort behaves in an intermediate manner; and hence it should appear that the change begins during fer-

mentation, and is continued when the beer is kept in barrel. Still, however, it does not seem to depend simply on fermentation, since no such change occurs when fermented on a small scale; and, therefore, it may perhaps be due to deoxidization, which would be more likely to take place in a large quantity less exposed to air.

If in any case it were desirable to ascertain whether or no any mixed liquid contained beer, the various reactions with the reagents already mentioned might enable us to form a very decided opinion when other tests failed; but so much would depend on the circumstances of the case that no general rule could be given.

On Some Adulterations of Malt Liquors.

I have made very many experiments in order to ascertain how far the spectrum method can be employed in detecting adulterations in beer. Many of the substances used are added in such small quantities, and impart so little colour, that there seems to be no chance of discovering them by their spectra. I have chiefly directed my attention to those employed as substitutes for hops, such as picric acid, gentian root, calumba root, and the entire plant of *Ophelia chireta*, commonly known by the more simple name of chiretta. So far I have not been able to detect any difference between the colouring matter of gentian, or chiretta, and hops. They all give the same reactions and spectra with the various reagents, or at least so nearly the same that there appears to be no chance of detecting them in the presence of the colouring matter of wort or beer. Calumba root, however, contains two colours, one of which is quite different from any that should occur in genuine malt liquors. The exterior part of the root is yellow, and water extracts from it a bright yellow colour. The interior part is browner, and does not contain this yellow, but a browner colour, which also occurs to some extent in the outer layer. On evaporating the aqueous solution to small bulk and redissolving in alcohol this brown colour is left insoluble, but the bright yellow colour remains in the alcohol, in a curiously turbid condition. The brown colour appears to be identical with that found in liquorice, and could not be detected by any of the reagents; but the yellow colour may be recognised, if beer has been adulterated by a moderate amount of calumba root. When dissolved in water or alcohol it is a very clear, bright yellow, but gives no well defined spectrum. Ammonia makes it slightly orange, and when dissolved in sulphuric acid it is the same bright yellow as in water. Oxidizing reagents, such as hypochlorite of soda, pro-

duce no change in weak acid solutions; but when added to the solution in sulphuric acid they alter it into a deep red colour, changed into an orange-yellow by excess. Deoxidizing reagents, such as hyposulphite of soda, restore the deep red to the original yellow. The most useful test in connection with the various other colours already described is hypochlorite of soda gradually added to the solution in sulphuric acid. This first makes it a deep red, giving the spectrum 3 .. 4 - —, and the addition of a little more produces scarcely any further change; but when large excess has been added it fades to an orange, giving the spectrum 6 . - 7 —. The colouring matter of fresh wort treated in the same manner is not turned at all red, and though the colour of finished beer is changed to red in a very similar manner, yet, after so much hypochlorite has been added as to turn it deep pink-red, a very little more makes it pale yellow. We may take advantage of this circumstance to detect calumba root.

In examining any suspected beer, it, and a similar quantity of genuine, should be evaporated in separate dishes, so that the results may be more accurately compared. The presence of calumba root is first somewhat betrayed by the fact of the resin which separates on evaporation being abnormally yellow, and when the syrup is dissolved in alcohol, and the solution evaporated to dryness, the purified colour is decidedly brighter yellow than it ought to be. Taking then two experiment cells, so much of the colour of the genuine beer should be dissolved in one—in sulphuric acid—as to give a decided orange yellow, with a spectrum 5 .. 6 - - 7—; and in the other cell so much of the suspected material as to give a colour of about the same tint. In both cases about one fourth of the bulk of the liquid should be alcohol, so as to prevent the formation of any precipitate. Hypochlorite of soda should then be added very gradually, and in equal quantities to both, when at first both will change to red, having a pinker tint in the genuine. After so much has been added as to make both as dark as they can become, a little more will turn the genuine to a pale yellow, giving a spectrum 7 .. 8 - - 9—; whereas that containing calumbia root will remain a fine red orange, with a spectrum $3\frac{1}{2}$ .. $4\frac{1}{2}$ - - 5—. If too large a quantity of the hypochlorite be added the colour of the calumba root will change into a much paler yellow, scarcely differing from that in the case of genuine beer, and hence particular care must be taken to add it gradually, and in small quantities. By this means the adulteration of beer with two ounces of calumba root to the gallon may be detected with confidence, but much less than that would scarcely give reliable results, unless it

were possible to examine the unfermented wort. The addition of the hypochlorite to genuine wort does not turn it at all red, and merely alters it to a pale yellow; whereas, if calumba be present, it turns it to a decided red.

Picric acid may be detected when present in no larger quantity than one grain to a gallon. When dissolved in water it is of a bright yellow colour, and cuts off the blue end of the spectrum in a sufficiently well-defined manner, giving the spectrum $8\frac{1}{2}$ . . . This is not changed by ammonia or citric acid, nor does hypochlorite of soda cause it to fade when added to an acid solution. The most striking change is that produced by the addition of sulphuric acid, which makes it so much paler that a couple of drops added to the aqueous solution in one of the small cells leaves it nearly colourless. In order to detect it in beer, about one ounce should be evaporated to dryness, and then redissolved in no more water than will make the solution sufficiently liquid to allow bubbles to rise readily through it. This should be introduced into a test tube and agitated with ether, which dissolves out the greater part of the picric acid, but scarcely any colour from genuine beer. Since it is very important to avoid contamination with any of the material not soluble in ether, it is well, in the first case, to use somewhat more than the bulk of the concentrated beer, and to transfer it to another *perfectly dry* test tube, then agitate with a fresh quantity of ether and add it to the first, arranging so that the total amount of ether may fill a half-inch test tube to the depth of about two inches. After corking it up it should be allowed to stand till quite clear, and till any particles not soluble in ether have adhered to the sides of the tube. The clear solution should then be poured off into another tube, water added so as to give a depth of about half an inch, and well agitated with the ether. After it has collected at the bottom the ether should be removed by a pipette, the aqueous solution washed with a little fresh ether, and then evaporated to dryness. In the case of genuine beer the ether extracts scarcely any colour, and the greater part of this and the resinous matter afterwards remain in the ether, so that on evaporating the aqueous solution, which is scarcely coloured, a mere trace of a yellow colour is obtained, so free from resin that, when dissolved in water and a drop or two of alcohol added, we obtain a clear, very pale yellow solution, so pale that if one ounce of beer has been used the spectrum is about 10 . . 11.—, changed to about 9 . . 10 - - 11— by sulphuric acid. If, however, picric acid be present the solution in ether is a decided clear bright yellow; the greater part of the colour is extracted from it by

the water, and on evaporating to dryness more or less of a clear bright yellow is obtained. If as little as a grain per gallon were present, when dissolved in water with a drop of alcohol a clear bright yellow solution would be obtained, giving the spectrum 8 . . . made much paler by the addition of sulphuric acid, which decolorizes the picric acid, and merely shows the colour of the beer itself, which, if one ounce had been used, and all the product introduced into the experiment cell, would not be deeper than 9 . . 10 - - 11—, or very decidedly paler than what would be seen before the addition of sulphuric acid, if even less picrid acic than one grain per gallon had been present in the beer.

I have not been able to discover any essential difference between the colouring matter of *Cocculus Indicus* and that of liquorice ; and though it would be difficult to prove it in a positive manner, yet I think it very probable that a small quantity of this colouring matter is the cause of the brown colour of chiretta, and of the slightly brown tinge in hops. It would, therefore, be impossible to detect *Cocculus Indicus* in porter by means of its colouring matter, even if present in far larger amount than is ever likely to be the case.

Though the detection of turmeric in beer does not necessarily depend upon the spectrum microscope, yet the method employed is so closely related to our present subject that it may be well to describe it. The best test for its presence is the very strongly fluorescent character of the solution in benzol. The alcoholic solution is much less fluorescent. In order to be able to detect fluorescence and examine the spectrum of the dispersed light, I have found it very convenient to make use of cells about three quarters of an inch deep, made out of moderately thick barometer tube, having an internal diameter of about one sixth of an inch, cut square and polished at one end, and melted up at the other, which is fixed into a small brass foot by means of black sealing-wax. On introducing a clear solution, covering it with a small piece of thin glass, illuminating the tube at the side by strong daylight, and looking down the axis, the liquid appears quite black, if it be not at all fluorescent, for no light is reflected from either the apparatus or the liquid ; whereas, if fluorescent, it looks more or less opaque and of a colour depending on the nature of the substance. Such tubes can easily be placed on the stage of the microscope, and the spectrum observed, which in some instances is remarkable in showing one or more narrow bright bands.

In the case of turmeric, a very minute quantity dissolved in benzol gives a beautiful more or less blue-green fluores-

cence, with no special dark or bright bands. Half an ounce of the suspected beer should be evaporated to so small a bulk that it may occupy only about half an inch in the depth of a test tube half an inch in diameter, and an equal amount of benzol added to it, with about an equal quantity of alcohol; since without this last the globules of benzol collect together with extreme slowness. After well agitating the whole, the tube should be set aside until the benzol has collected at the top, as a clear solution, which must then be introduced into one of the cells just described, by means of a pipette. In the case of pure beer, this solution is of a faint yellow colour, but is scarcely at all fluorescent. If no more than one grain of turmeric has been added to a gallon of beer, the fluorescence is so strong that it could not be seen to greater advantage, and even as little as one tenth of a grain per gallon may be detected with confidence.

It will thus be seen that the spectrum method of study serves to throw considerable light on some of the changes that take place in the process of brewing, and would also enable us to detect the presence of some adulterations; but, at the same time, it would always be requisite to bear in mind that it is possible that some of the colouring matters I have described may themselves become altered when kept in solution for a considerable time.

Adulteration in Drugs, &c.—Mustard.

I now proceed to describe the detection of adulteration in a variety of substances. Having just explained the method to be employed when the presence of turmeric is suspected, it may perhaps be well to mention now all that need be said on that substance. Its presence may easily be detected in nearly all the ground mustard sold in the shops; and, as far as I am able to judge from the intensity of the fluorescence, the amount varies from about one third to one half per cent.

The natural seeds contain a yellow colour soluble in water, which is the same as that found in many yellow leaves; another yellow colour, insoluble in water, but soluble in alcohol, which corresponds with the xanthophyll of yellow leaves; and there is also often present a small quantity of chlorophyll, in the imperfectly ripe seeds. The powdered mustard should be digested in alcohol, about an equal quantity of water added, and the solution filtered. On agitating with benzol this rises to the top, with the colour of the turmeric in solution, which can be easily detected by its strong green fluorescence. Chlorophyll, if present, would give a red fluorescence, and by transmitted light a spectrum with well-marked absorption bands.

Rhubarb.

The same process may be successfully employed in the case of rhubarb, and as small a quantity of turmeric as one tenth per cent. may be detected in no more than two and half grains of rhubarb. There is not the least difficulty in distinguishing by this means inferior pale rhubarbs, coloured by turmeric so as to resemble those of the best quality.

The detection of small quantities of gamboge, added to increase the purgative action of these inferior kinds, is not so easy, and requires some care, especially in the presence of turmeric. The suspected powder should be placed on a small filter, and so little alcohol added as will give a few drops of clear solution, which would contain a comparatively large amount of the very soluble gamboge, and but little of the less soluble colour of the rhubarb itself. This alcoholic solution should then be agitated with bisulphide of carbon, and the supernatant alcoholic solution removed by means of a pipette and blotting-paper, and the solution in the bisulphide evaporated to dryness. This would contain a colour peculiar to the different kinds of rhubarb, and, perhaps, also turmeric and gamboge. If a small quantity dissolved in benzol gives the green fluorescent solution, turmeric is present; and in order to detect the gamboge it would then be requisite to redissolve in alcohol, and add a little nitric acid, which so changes the colour of the turmeric that it is no longer removed by agitating with bisulphide of carbon; whilst the gamboge remains unchanged and is abstracted by it from the alcoholic solution. After separating this, evaporating the bisulphide to dryness, and redissolving in alcohol, a small quantity of an alcoholic solution of iodine should be added, and then excess of ammonia, a little sulphite of soda, and a drop of water to make it dissolve. This ensures the complete removal of any free iodine that may remain after the addition of ammonia.

In the case of pure rhubarb this solution, when sufficiently but not too strong, has a decided pink colour, giving no well-marked absorption band in any part of the spectrum, but transmitting the blue rays very considerably better than the green; whereas, when gamboge is present to the extent of two per cent. or upwards, the yellow colour due to it cuts off the blue light, and the solution is orange colour. The spectra are as follows:

Pure rhubarb	4 ... 8 9 .. 10 — — 11 —
Rhubarb, with 2 per cent. of gamboge .	4 ... 9 — — 10 —
„ „ 4 „ „ .	4 ... 8 — — 9 —
Gamboge alone	7 .. 8 — — 9 —

In very many other cases bisulphide of carbon is a most valuable reagent to separate different colours. An excess should be agitated with the alcoholic solution, when it sinks to the bottom, carrying with it the whole of some colours, and leaving the alcohol quite colourless. Other colours are only partially removed, whilst others are not abstracted in the least degree. These last are usually, but not always, those soluble in water, whereas those easily removed are usually, if not always, insoluble in the liquid.

The cells for the examination of the spectra of solutions in bisulphide of carbon, ether, chloroform, or benzol, should be fixed to the glass plate by means of a mixture of glue and honey made so as to be quite stiff, but yet to melt when warmed. Cells so cemented must be washed out with the liquids named above, and never with water or hydrous alcohol. The spectra of colours dissolved in the bisulphide are far more characteristic than when dissolved in any other liquid. So far, I have met with between two and three dozen different vegetable colours soluble in this reagent. The absorption bands are much farther removed from the blue end, when they occur in that part, so as to be far more distinct; and their position is not subject to variation from any change produced by evaporation, as in the case of ordinary alcohol, which may thus become more weak and give the bands in a very different situation.

On the whole, the spectra are so characteristic and uniform, that different colours, soluble in bisulphide of carbon, may usually be recognised in a very satisfactory manner by means of the spectrum of that solution alone, and this is fortunate, since such colours can seldom be distinguished by their behaviour with reagents. The dried colour must be dissolved in fresh bisulphide, since when it separates from the alcohol it contains some of that liquid in solution, which alters the position of the bands. As an illustration of what may be done I give a few examples:

Cheese.

Cheese of orange colour was digested in bisulphide of carbon, the solution washed by agitating with alcohol, and evaporated to dryness. On redissolving in alcohol, diluted with a little water, a considerable amount of oily matter was separated; and after evaporating the clear solution to dryness, and redissolving in bisulphide of carbon, it gave the spectrum $5\frac{1}{8}$ $7\frac{1}{8}$, which corresponds exactly with that of red annatto.

In all such experiments it is requisite to use deep experiment cells (I use one two and a half inches deep), so that the

amount of the bisulphide may be large in comparison with that of the oils, since the presence of much oil causes the bands to lie nearer the blue end, and thus interferes with the production of the characteristic spectrum.

Butter.

Treating yellow butter in a somewhat similar manner, I obtained the spectrum 6 $7\frac{1}{2}$. This differs entirely from that in the case of cheese, and corresponds with the spectrum of the colour of the exterior orange portion of carrots; but I am not quite certain whether this might not be derived from carrots eaten by the cows, though I am more strongly inclined to believe that it had been artificially introduced to increase the colour of the butter.

The difference between the spectra of the above-named colours and of various others closely allied to them will be better understood from the following table. In all cases they are those of the solutions in pure bisulphide of carbon:

Red annatto	$\frac{5\frac{3}{4}}{\cdot}$	$\frac{7\frac{1}{2}}{\cdot}$	
Exterior of carrot and the skins of several kinds of fruit	6	$7\frac{1}{2}$	
Xanthophyll of many yellow leaves and flowers, and of the interior of carrots	$6\frac{1}{2}$	8	
Colour of the petals of Brassica, and of many other yellow flowers	$\frac{6\frac{3}{4}}{\cdot}$	$\frac{8\frac{1}{4}}{\cdot}$	
Orange-yellow colour of turnip roots, and of the flowers of Eryssimum Perofskianum	$5\frac{1}{8}$	$\frac{6\frac{3}{4}}{\cdot}$	$8\frac{3}{8}$

It will thus be seen that these spectra differ from one another so much as clearly to show that they are due to different substances, which are often further distinguished by their different behaviour with bisulphide of carbon and alcohol, some being almost entirely, and others only very partially removed from the alcoholic solution by that reagent, so that they may be separated when two occur mixed, as is not uncommon in some leaves and flowers. By first agitating the alcoholic solution with a little bisulphide, and washing this with alcohol, one may be procured nearly pure; and then, after agitating with a second small quantity of bisulphide and removing it, the other colour may be obtained nearly pure by evaporating the alcoholic solution to dryness, and dissolving the residue in bisulphide, which leaves indissoluble any of those numerous colours soluble in water which so commonly occur in leaves, flowers, and fruits. It is now nearly two years since I determined the existence of a considerable number of distinct substances, of which at least eight have

lately been described by Dr. Thudichum[1] under the general name of *leuteine*. I think that this new name can only be looked upon as something like the old term *xanthophyll*, as hitherto inaccurately employed for a whole series of yellow colours, some of which correspond with some of those included under *leuteine*. If it were thought desirable to have a generic name, the term *leuteine* might indeed be employed; but I must protest against the idea that the substances described as such by Dr. Thudichum are one single colouring matter. Some of their properties are indeed very similar, but that is often the case with those substances which give closely connected spectra, even when other facts show that they are entirely distinct, for there seems to be a sort of correlation between optical characters and chemical reactions; but this is no reason why we should confound together substances giving absorption-bands in distinctly different positions in similar solutions.

Saffron.

The adulteration of saffron with the sliced petals of the yellow crocus could easily be detected, even in a solution, by means of the remarkable spectrum of the latter, when the product of the action of bromine is deoxidized by sulphite or hyposulphite of soda. To the alcoholic solution of the colours soluble in water an aqueous solution of bromine should be added very gradually, until, after having become quite pale, it is made slightly yellow by the addition of more. Excess of ammonia and a little sulphite of soda should then be added. In the case of pure saffron the liquid remains almost or quite colourless, whereas ammonia first turns the colouring matter of the crocus to a red, which soon becomes yellow, and then sulphite of soda changes it to a remarkably fine red, which is highly fluorescent of red-orange colour, the spectrum showing a bright narrow band at about $3\frac{1}{7}$. That of the transmitted light is very characteristic, and shows an excellent absorption-band at $4\frac{5}{8}$. On adding citric acid the colour becomes red-pink; it is still highly fluorescent, but of more yellow tint than before, the bright band being raised to about 4, and the absorption-band in the spectrum of the transmitted light is raised to $5\frac{1}{8}$; but the addition of hydrochloric acid destroys both the fluorescence and the absorption-band. The only colour that I have met with analogous to this is one which occurs in the yellow flowers of several plants allied to the common wallflower (*Cherianthus Cheiri*), but the bands

[1] 'Proceedings of the Royal Society,' vol. xvii, p. 253, January, 1869.

are in distinctly different positions. The production of the fluorescent colour is apparently due in both cases to deoxidization, for even proto-sulphate of iron has the same effect as sulphite or hyposulphite of soda. If too much bromine be added, this change does not take place; but by a little care a small amount of the petals of the yellow crocus could be detected in a considerable quantity of saffron. The presence of safflower might be recognised by a similar process, but not so decidedly. After adding bromine and ammonia it remains distinctly yellow, but gives no absorption-band; whereas pure saffron is thereby quite decolorised.

Aloes.

I have tried a number of experiments in order to ascertain whether it would be possible to detect the adulteration of the soccotrine aloes with the hæpatic, but have not yet succeeded in discovering any satisfactory method. It appears as if both contain the same general colouring matter, but the soccotrine a second in addition. When ammonia is added to the alcoholic solutions, the soccotrine gives a more orange colour than the hæpatic, and the green part of the spectrum is more absorbed, so that when compared side by side the spectra are—

Soccotrine . . .	4 ·· 6½ — —
Hæpatic	6¾ — —

It would, therefore, be possible to distinguish them from one another, or to detect the soccotrine in the hæpatic, which is, however, the reverse of what would be likely to occur, since inferior things are not often adulterated with better.

Adulterations by means of Cochineal and Magenta.

Cochineal may be best detected in the tincture of roses by adding to the aqueous solution bicarbonate of ammonia and sulphite of soda. This changes the colour of the pure tincture to a very pale yellow, but that adulterated with cochineal to a light red. The spectra are somewhat thus:

Pure tincture . . .	8 ·· 9 — — 10 —
Adulterated with cochineal	3¼ ·· 7 — — 9 —

The presence of magenta might be recognised by the spectrum of the solution in its natural state. The pure tincture shows no narrow absorption band in the green, whereas magenta gives a very distinct one, situated at 5 of my scale. In the case of the syrup of damsons and similar fruits, magenta may be detected, when in very small quantity, by

agitating a dilute alcoholic solution with chloroform. If so much alcohol be added as only to partially dissolve the chloroform, scarcely a trace of the magenta is left in the alcoholic solution, and the characteristic spectrum can be easily seen by examining the chloroform, which scarcely abstracts any other colour. Ammonia produces no change in a solution of magenta in dilute alcohol, but the absorption band is immediately removed by a mere trace of sulphite of soda.

It would scarcely be a correct description of the facts to say that cochineal may easily be *detected* in pink-coloured confectionery, since in some cases its spectrum is seen to almost as great advantage as in any condition without any preparation; and it could generally be recognised with very little manipulation.

No doubt many other applications of methods similar to those I have described would present themselves to any one engaged in technical inquiries. I do not for one moment pretend to have exhausted the subject. I have merely examined various questions in order to ascertain what methods might be employed with advantage, and I trust that the cases described above will, at all events, facilitate the application of this kind of qualitative analysis to practical questions, for I have met with many who were anxious to employ it, but had not sufficient time at command to make the preliminary experiments, which are so very necessary in all such inquiries.

On Draparnaldia cruciata, *Hicks.*

By J. Braxton Hicks, M.D., F.R.S.

With Plate XIX.

The Draparnaldia, of which a drawing for the first time is now given, was described by me in the 'Journal of the Linnæan Society,' November 18th, 1857. It was discovered by me in the gentle streams issuing from the bogs of the New Forest in several localities. Subsequently, among some drawings sent to me by Mr. G. S. Brady, Secretary of the Tyneside Naturalist Field Club, in order to be named, I was pleased to find a very accurate representation of this alga. It was found by him in the peat bogs near Crag Lough, Northumberland, and is mentioned by him, along with others found in the same locality, in the sixth volume of the 'Trans. Tyneside Naturalist Field Club.'

The species is remarkably distinct from the others hitherto

described, and possesses characters which render it a connecting link between the genus Draparnaldia and Chætophora.

Nothing is more remarkable than the direction taken by the branches, which diverge strictly at right angles to the stem. Even the lesser kinds, called tufts, and their branchlets, pass off in this way, and as four generally spring from the same point, there is a cruciate arrangement in every part. The colour of the endochrome is light greenish-yellow, and as the quantity is but small relatively in the larger cells, the appearance of a mass of it is very different from the rich green of the other Draparnaldiæ. Again, from the profusion and the extreme length of the ciliæ, a mucoid appearance is given it when removed from water. But this mucoid appearance has a real basis different from all the other species. A very perceptible sheath of "mucus" surrounds the principal filaments.

Now this is not found in *D. plumosa*, *glomerata*, and *repetita;* for although their fronds are called "gelatinous," this latter appearance depends on the number of ciliæ, and not on a sheath of "mucus," at least, I have never so found it in the species of Draparnaldia I have seen. In this particular this species brings Draparnaldia into closer relationship with Chætophora than heretofore.

It may be useful to repeat the description of the species.

Frond 3—4 inches long. Light green colour, not so green as *Drap. glomerata* and *plumosa*, possessing a flocculent appearance when in water, and highly mucous when out of water. To the naked eye and a low magnifying power it has the appearance represented in fig. 1, which is magnified about four times the natural size.

Every portion is surrounded by a distinct layer of transparent mucus, extending on each side to the distance of 3 diameters of the included ramulus. This is most easily seen after two days, when extraneous matter adheres to the mucus.

The main filament is composed of cells very slightly inflated, 3—4 times longer than wide, about $\frac{1}{330}$th an inch wide; delicately fasciated.

Primary ramuli proceeding at *right angles* chiefly in whorls of four, from the main filament, with an interval of 50—60 cells. The sub-ramuli also proceed in the same way from the primary ramuli, giving the plant a cruciate appearance, as in fig. 1, &c.

The cells of the ramuli as wide as long; the larger fasciated, the smaller quite filled with green chlorophyl.

The interspace of 50—60 cells of main filament being

great, to the naked eye it appears nearly bare, but by higher magnifying powers small tufts, like those terminating the subramuli, appear at about every ten cells; some larger, and approaching somewhat the subramuli, while the others are very simple. The larger terminal and lateral tufts have a pyramidal form, and from all their divisions proceeding at right angles, it appears much like a fir tree.

All the ultimate tufts bear cilia, as in the other Draparnaldiæ, but of extreme length and tenuity in this species.

From the 1—3 basal cells of the ramuli, often roots, spring, coiling themselves round the main filament, and even spreading away from it, and sometimes the free point becomes converted into a tuft, like those on the main filament. The smaller tufts at times possess them. When the plant is mature the ramuli disengage themselves and can be seen floating about with their roots probably ready to attach themselves to any suitable object, and so become separate plants.

This, as the other Draparnaldiæ, produces zoospores which are not so large as in *D. glomerata*, being oval and about $\frac{1}{2140}$ inch long diam., and about $\frac{1}{3750}$ inch of short diam., with a cilia. A whole tuft undergoes the process simultaneously.

This species is found in the small streams rising from the bogs in the New Forest. It was found in June in 1853, and in July in 1855, associated with a Batrachospermum, which it much resembled at first glance. It attaches itself to sticks, stones, &c.

It can easily be distinguished from *D. plumosa, glomer.*, and *rep.*, by the divisions diverging at right angles, and in whorls of chiefly four (giving the cruciate appearance), the perceptible mucous sheath (bringing it near to Chætophora), the exceeding delicacy of the cilia; extreme tendency to give out radicles; the nearly equal of width of the main cells, as also their greater length. The fir-tree-like form of the tufts are so unlike the flexible shape of the other species.

On Some Freshwater Rhizopoda, New *or* Little-Known. By William Archer.

Pompholyxophrys punicea, gen. et sp. nov. (Pl. XVI, figs. 4—5.)

(*Continued from p.* 271.)

The next form which claims attention is one of which I might, perhaps, cursorily convey an idea by saying it represents an Actinophrys invested by a stratum, more or less deep, of minute hyaline colourless vesicles, these latter of very slightly varying dimensions, and from amongst which emanate the very slender and delicate pseudopodia into the surrounding water. But it appears to me that this would hardly give a correct impression of this form, for in Actinophrys there are one or more marginal pulsating vacuoles present, whilst a repeated observation of this rhizopod, not at all uncommon with us in our moor ponds, has not shown that it possesses this characteristic.

We have here, as in the various forms previously adverted to—"Radiolarian" except in the possession of the essential "central capsule"—an orbicular sarcode body, with a sharply defined outline (which has never displayed marginal pulsating vacuoles), and which gives off therefrom a number of linear, very delicate, hyaline and colourless pseudopodia (fig. 4). This central body is densely loaded with pigment-granules, the majority of which are ordinarily of a deep reddish or crimson, inclining to a purple colour, which, under all magnifying powers by which so minute a form can be detected, imparts to it a very distinctive character. There are besides some colourless and some greenish granules to be noticed, mingled with the characteristic reddish ones, when it is examined under a high power; nothing like a "nucleus" has hitherto been seen. The pseudopodia are often very hard to be made out; they can be sometimes seen to vary somewhat in thickness, and sometimes appear to be thicker above than at the origin, and they are straight and comparatively rigid. They do not ever seem to coalesce, nor do they seem much to exceed in length, at most, the diameter of the body. Covering the body in a more or less deep stratum are seen a number of colourless, hyaline, spherical, sharply defined (soap-bubble-like) vesicular structures. These vary a little in size, but are always very minute. They do not seem to possess any nuclear or granular contents under even a $\frac{1}{7}$th objective. Between the periphery of the central body and this stratum

of vesicular structures there appears to be an exceedingly minute interval; that is, the lowest vesicles or those nearest the central body do not seem to be in absolute contact with it, but separated therefrom all round by an appreciable equidistant space, which, in a certain position of the focus and of the light, appears like a clear white even line, between the periphery of the inner body and the outer stratum of vesicles. The vesicles themselves are in contact with each other, but do not *seem* to have any mutual connection, though resembling what vegetable histologists might call a merenchymatous tissue. In fact, they are somewhat easily detached by pressure, and can be made to float away independently.

In fig. 5 I have depicted the appearance of an example of this form after having been submitted to pressure, by force of which a portion of the body-mass became extruded, and some of the outer vesicles projected to a distance. A number of the reddish granules are seen hard by, where they assumed a molecular dancing movement; and some of the vesicles are also seen removed, and freely distributed in the surrounding water. The outline of the central body presents a sinus at the place whence a portion of its mass had become extruded, and thereat the sarcode shows a hyaline appearance, due to the loss of the colouring granules. The figure of the specimen has been made at this point. Such an example, however, in a few moments—the sinus gradually becoming obliterated—is able to reassume the globular form, the only difference being that at the region whence the reddish granules have been expelled the body remains for a time comparatively colourless, and the outer vesicles, now diminished in number, become rearranged pretty equidistantly over the periphery in a single file, or more or less interruptedly, instead of presenting a layer two or three or more deep, as in the usual examples.

This does not appear to be a very ravenous species, but examples are to be met with containing a variety of crude food, such as protococcoids and minute diatoms. Sometimes specimens are seen containing, perhaps, some navicular diatom of considerable comparative length, which causes the ordinary orbicular form of this rhizopod to become distorted more or less, and to assume an elongate, or elliptic, or broadly spindle-shaped figure. When an unusually long diatom is taken in it may cause the normal outline of the rhizopod to project to a comparatively great extent beyond the ordinary limits at its two ends, these being then invested by an exceedingly thin and tense stratum of the sarcode body, and only a single layer of the outer vesicles spread over the whole. In fact,

it sometimes may look as if the diatom projected right through and through the body, and as if it pushed up and away along with it, at opposite ends, a few of the outer vesicles, carrying them scattered on its surface, thus giving such an example a very singular appearance.

I have not been able to see the inception of food, but have noticed the ejection of crude, presumably indigestible, matter, such as, seemingly, the skin or wall of some protococcoid. This is effected by a somewhat sudden effort, looking, at first sight, like a breaking into two of the rhizopod itself, but it is only the turning out or eversion of the undigested rejectamenta. However, during this act of what may be called defecation some of the colouring granules are likewise simultaneously ejected, and a few of the outer vesicles thrown off; this, of course, accidentally and seemingly caused by the mechanical action involved in the effort. The creature does not seem to suffer by this loss of a portion of its substance, it shortly reassumes its orbicular figure and shows no change except the certain small amount of loss of colour, just as in the example subjected to artificial pressure before described.

Of all actinophryan or "radiolarian" forms that I have seen this appears to me to possess the greatest amount of locomotive power—next to it in this respect, perhaps, comes the form I have previously mentioned under the name of *Heterophrys Fockii*. The present form often makes very decided changes of place as it is viewed under a quarter-inch. It seems occasionally to be able to roll along with a certain slow and undecided but perceptible amount of vigour, as if its slender but hardly evident pseudopodia performed the part of ambulatory organs; but at other times no motion or change of place at all is noticeable.

As in other rhizopods which present a distinct coloration, it must be presumed that the intensity of the reddish or garnet colour, inclining to purple, characteristic of this species, is due to condition of nutrition. Examples presenting themselves in gatherings kept for some time in the house are paler in colour than those met with in fresh and healthy gatherings which abound with other forms of animal and vegetable life. Still, though paler and fewer, the reddish granules seem never to be wholly absent. Such examples, too, besides the paler colour, likewise show the outer vesicles, not only fewer, but seemingly more or less diminished in size or shrivelled and collapsed; but I have not seen specimens from which they were absent, though they may have lost their spherical bubble-like appearance.

I regret to say I have never met with examples showing

any reproductive or further developmental condition. As I have mentioned, no "nucleus" discloses itself to my examination, either in the central body or the external vesicles. I can throw no light on the growth of the latter, nor how they self-divide or increase in number. It is clear they are not vacuoles or cavities in the marginal region of the rhizopod, but distinct, (so to speak) independent structures; still, as is seen, there must remain a doubt as to whether they could be regarded as justly laying claim to the dignity of "cells." But they seem sufficiently curious and remarkable. Unlike the true "cells" of Cystophrys (described *antè*, p. 259), they are not contained within the sarcode body, and thus retained *in sitû*, but are freely deposited externally, and yet remain there unless detached by accidental external or internal force. At least I have been unable to see any bond of union or matrix, that is, any external thinner sarcode layer by which they could be retained. Indeed, there appears, as has been mentioned, to exist a very narrow, but appreciable, (as it were) vacant, interval between these outer vesicles and the external surface of the actinophryan body, that is, when an equatorial plane is brought into focus, but the vesicles themselves mutually touch. But, after all, without their being involved in some exceedingly delicate sarcode matrix surrounding the central body, it is difficult to see how they could rearrange themselves upon the surface of the latter, when they are mechanically disturbed, or even be retained around it. But if there be such a soft and delicate layer, it is not as yet evident to the closest examination, so far as I can see.

This is the only freshwater rhizopod that I know of showing the peculiar red colour of the pigment-granules which I have tried to describe and portray; there are, indeed, rhizopodal forms, or developmental states of such, of a buff or orange colour, but none exactly like the present.

This form, whose short diagnostic character I defer to the end of this paper, is by no means uncommon in our heath pools in different parts, but it always occurs isolated, never abundantly or in groups. I have seen it from the south and north of Ireland, but in the county Wicklow (Callery and Carrig) it occurs more frequently than in other places. I have for some time familiarly called it (for want of another appellation) the "red bubble-bearer," in allusion to its soap-bubble-like vesicles, and I have thought, in the choice of a name for the genus which it must represent, that it might sufficiently appropriately retain the title under the new shape of *Pompholyxophrys punicea*.

Gromia socialis, sp. nov. (Pl. XX, figs. 7, 8, 9, 10, 11).

Passing on from the freshwater rhizopods of the "Radiolarian" type, which have been the subject of the preceding pages, and in continuation of these casual notes of new or little-known forms which I have from time to time had the opportunity to meet with, I have now to draw attention to one of a different group which is amongst the most minute, but one at the same time seemingly very well marked. Unlike some of those which have formed the subject of previous communications in the preceding pages, the present does not demand a new genus for its reception, as it falls, as will be seen, in my own opinion at least, as a new species under the genus Gromia (Duj.).

Those, indeed, who are acquainted with the much larger representatives of the genus, such as even the comparatively small *Gromia fluviatilis*, and conceiving that form magnified 400 diameters, that is, to the scale of the accompanying drawings (Pl. XX, figs. 7—11), being that to which all my previous figures have been made, might hardly be disposed to regard these two as strictly congeneric, or they might, on the other hand, regard the present as, perhaps, simply a young state of *Gromia fluviatilis*. But the present form has other and further resemblances, to which I shall draw attention after having first given some account of it. Nay, this inert, at first glance nearly lifeless-looking, organism might almost be taken for some species belonging to the fungal genus Chytridium, and not as appertaining to animal life at all, only that it occurs free in the water, and not living parasitically (as would a Chytridium) on some confervoid or other host.

But if I was for a little somewhat puzzled by the Chytridium-like appearance of this form, rendered the more misleading by its occurring in the gathering chiefly amongst the branches of *Microthamnion Kützingianum* (Näg.), a short examination soon dispelled that idea, and made it certain that I had indeed a true rhizopod before me. Amongst the ramifications of almost every example of this little alga in the gathering—never, indeed, in any way attached to them——occurred this little rhizopod, either singly or in groups of two, three, four, five, six, or even more; and it is sufficiently remarkable that I but seldom met with them in any other situation in the gathering at large; so that whilst they lasted I presently found that the quickest way to meet with specimens was to look out for a plant of the Microthamnion, and then search with a "quarter-inch" amongst its branches for the little Gromia, which, however, owing to its minuteness,

and being thus often above or below the plane of the focus, readily eluded observation. I can in no way account for the proclivity of this little rhizopod for poising itself amongst the branches of the alga referred to, between which it sent its own ramifying pseudopodia in various directions.

Those who will take a look at the drawing (Pl. XX, figs. 9, 11) may, perhaps, forgive my momentary misconception that I had a Chytridium before me, the pseudopodia being, perhaps, somewhat like the root-processes of the organisms appertaining to that type, the test corresponding to, and resembling not a little, the orbicular body of a Chytridium plant, which at maturity becomes ultimately the sporangium. But a more prolonged observation showed a slow, but not the less actual, flow of the granules along the branching, and here and there incorporating pseudopodia; nay, the circumstance that two, three or four, or even more individuals, might not unfrequently be found united by a mutual fusion of their pseudopodia in a more or less reticulate manner, and seemingly carrying on a common life, abundantly proved the true nature of this organism.

This, then, is an undoubted rhizopod. It possesses a minute, nearly orbicular, or very broadly elliptic, quite hyaline, colourless and smooth test, which encloses a sarcode body-mass of a bluish kind of tint and densely granular appearance, resembling that seen in the so-called nucleus of Amœba and others. This in the greater number of cases, when the examples are fresh, does not come into contact with the inner surface of the test, from which it mostly seems to stand off some appreciable distance, partially or all round, though occasionally closely invested by it. At one point of the test, sometimes indicated by a gentle elevation in its figure, is given forth an emanation of the sarcode, hyaline in appearance as compared with the central body-mass, and from this proceed, in variously extending ramifications, the sometimes very long pseudopodia. These pseudopodia branch considerably, and inosculate at different points, not only with those of the same example, but frequently also, as has been mentioned, with those of neighbouring individuals (fig. 7).

The pseudopodia sometimes assume even fantastically drawn out, remotely extending, ramifications (figs. 7, 8); they sometimes proceed, though this far less commonly, as a vertical slender stem, and then branch off in a dendroid manner at the top (fig. 9); they often, however, emanate simply as a tuft or shrub-like cluster (fig. 11), and a few often singly, or in minor groups, are directed backwards. The pseudopodia themselves are hyaline, but carry a con-

siderable number of minute, but variously sized, opaque granules. Along their length, or at the points of fusion or where branches are given off, there often occur little variously shaped expansions or dilatations, in which a few of the moving granules seem to find a temporary repose. At first sight the whole looks dead and motionless, but a short observation shows the current of these granules along the course of the pseudopodia very perceptibly. In very many of the specimens comparatively large aggregations of granules, considerably larger than the average, presented themselves, and the movement of these clusters was more rapid than that of the individual more minute granules. Thus, the cluster or little aggregation of granules shown near the lowest specimen in the figure of the group of three herewith (fig. 7) took about a minute to travel from a position as near the upper individual as that now shown occupied by it as regards the lowest. Not only is there this slow and rather fitful "cyclosis" of the granular contents of the pseudopodia, but a more prolonged examination soon shows that there is a constant but gradual change of position, of degree of ramification, and of reticulated arrangement of the pseudopodia themselves.

Sometimes a club-shaped or dilated expansion of a pseudopod, not inosculated with any other, exists in certain examples, and, within such, a cluster of coarser granules, similar to those seen in the intermediate dilatations of the mutually incorporated pseudopodia of different individuals, is usually presented (fig. 10).

These larger, shapeless, and irregular granules may possibly represent food becoming digested, for it is not readily to be seen how such kinds of crude food as ordinarily form the nutriment or prey of Rhizopoda could find an entrance into the test in their entirety.

It must, I think, follow, from what has been stated, that this creature naturally falls under Dujardin's genus Gromia.

But there are further characteristics to be mentioned and resemblances to be adverted to which may, perhaps, hereafter, in the opinion of some, be found to render its position in that genus as possibly not quite tenable.

When I first endeavoured to make out the characteristics of this little rhizopod, and, having regard to the appearance presented by the densely granular, bluish, internal body-mass, I was inclined to look upon this as equivalent to the "nucleus," occupying, indeed, it would be true, by far the greater proportion of the body. It looked as if this was suspended in a sarcode mass of quite hyaline appearance, filling

the interval between it and the test, and giving off the pseudopodia through the part of the test at which exists the opening for their emission. But no one could look long at examples of this creature without readily perceiving a small, orbicular, whitish body, itself containing a central well-marked, far more minute, darkish granule, immersed, often a little to one side, within the bluish granular body-portion. In fact, this little body, with its central dark granule, can, I imagine, hardly be otherwise regarded than as a true nucleus with a nucleolus. It could be found in nearly every specimen, if focussed accurately, with great readiness; where not seen, it can only be supposed that it was turned away from observation. But, further, the bluish granular body of the rhizopod was itself capable of becoming self-divided transversely, and in every instance in which this was seen there was a new white body with its black central dot—that is, a new "nucleus" with its "nucleolus" (to assume them as such)—in each half, and these generally near the recently divided surfaces of the rhizopod-body, so as to lie close to one another. In such cases of self-fission the upper half gave off its pseudopodia in the usual manner (fig. 11). I never could, however, see any further progress or development of these so divided examples.

There is much in the aspect of this rhizopod, both in its test, kind of pseudopodia, whitish nucleus and its nucleolus, and in the self-division of the contained body-mass, to call to mind the form I brought forward in a previous part of this paper (*antè*, p. 259) under a new generic and specific name, and called *Cystophrys Haeckeliana*. If, indeed, we imagine a very numerous group of individuals of the form now brought forward to be in immediate juxtaposition, and all to pour forth a large quantity of colourless sarcode from the oral aperture (if I may so use the word), and the cluster or group to become enveloped in the common sarcode mass—the whole group of individuals to become, in fact, mutually swallowed up therein—and then the marginal region to give off some comparatively short but pretty similar pseudopodia—if, indeed, we imagine all this, we should have something very like my *Cystophrys Haeckeliana*. But in the latter form the central cells show no opening; they seem to be true closed cells, contained in the common sarcode body, just like the "yellow cells" of the marine Radiolaria. Nay, the creature seems to shed these or extrude them during the exertion of incepting foreign matter of an extraordinary character or size, and this seemingly with complete *nonchalance*. See my second drawing of an example of this creature (Pl. XVII, fig. 2). Now,

under all circumstances these cells appear to be close all round, and, therefore, could not give off sarcode processes. In fact, so far as observation reaches, in *Cystophrys Haeckeliana* they must be regarded as contained cells, possibly comparable, as I have said, to the "yellow cells" of the marine types; whereas in the animal now drawn attention to the outer wall must be regarded as simply a test, and this notwithstanding the general resemblance of the two. Further, the test in the form now brought forward is larger than the cells of *Cystophrys Haeckeliana*, nor do the pseudopodia of the latter ever seem to reach the inordinate length of those of the present form. Again, the great difference in the relative degree of activity or locomotive power of the two is sufficiently striking. As has been mentioned, the movements of the present form are exceedingly slow and torpid, whilst in *Cystophrys Haeckeliana* the change of place and power of modifying the outward configuration of the general mass and of encompassing foreign bodies was very considerable, as was well evidenced by the example from which the second figure was taken (Pl. XVII, fig. 2).

On the whole, then, I think this form presents itself to us as a new and distinct rhizopod, one which fulfils the conditions which entitle it to admission into the genus Gromia (Duj.), but one which, as has been seen, offers some puzzling resemblances. I can, then, only hope that it may be met with elsewhere if searched for, and that thus the desirable observations of others who may work in this field may shed that light upon its development which the present imperfect remarks, I regret to say, fail to do, and that I may thus, perhaps, hope some day or other to have my views upon it confirmed, or, if ill-founded, to have them corrected.

Diaphoropodon mobile, gen. et sp. nov. (Pl. XX, fig. 6.)

I pass on to another novel form, and amongst those I have had the opportunity to bring forward probably, if not the prettiest, at least one of the most curious—one, indeed, which I apprehend, in one respect at least, is unique amongst Rhizopoda. It is not, of course, without affinities and resemblances in other respects, and to some of those I would briefly refer after first endeavouring to convey an idea of the present form.

An inspection of the accompanying drawing (Pl. XX, fig. 6) will assist in accomplishing that end. We have here to do with a rather large form, one of the largest, indeed of encased freshwater forms with which I am acquainted, its

rude test, if test it may be called, seemingly formed of heterogeneous foreign materials very loosely aggregated around the generally pretty regularly elliptic-shaped body. These foreign particles seem to be of very varied kinds (as in many Difflugiæ), such as diatomaceous frustules and fragments, arenaceous particles, protococcaceous cells (often seemingly living), brown peaty-looking particles, little indescribable shreds, all indistinguishably aggregated. From one end of this elliptic body the sarcode inner mass protrudes beyond this rude covering in an almost hemispherical or subconical form and from this comparatively bare prominence emanate the frequently numerous and very variably long hyaline pseudopodia. I allude to this anterior prominence as only comparatively bare, for it often carries forward a few of the various external foreign bodies here and there disposed upon it, allowing the surface of the sarcode prominence to be seen between. The pseudopodia, as has been alluded to, are given off mostly very copiously, and radiate in any and every direction, and are more or less ramified, but do not seem to inosculate. A striking peculiarity in habit of this rhizopod, as presented by many of the specimens met with, is that when first placed upon the slide for examination the pseudopodia are often seen to be prolonged to a very great and inordinate degree, and densely ramified at several points along their length (see fig. 6). At first glance, indeed, the tufts of what I might call secondary pseudopodia almost seem under a low power as if they did not even belong to the animal at all, but represented some other quite unconnected and independent rhizopod. But upon a more close examination it is seen that these tufts are really connected with the body of the creature by a direct continuation of the lower portion of a pseudopod emanating from the anterior region. Shortly after being placed on the slide, however, these extravagantly long pseudopodia are drawn in by a rather quick contraction, the tufts disappear, and all that now can be seen is a radiant and rather dense bundle of but slightly ramified pseudopodia, of the same character as the accompanying minor ones springing from the sides and elsewhere, as seen in the example figured. And in this latter way the pseudopodia mostly presented themselves in my specimens, because the very remarkably long drawn out and densely tufted form so speedily disappeared under observation, and no amount of patience in waiting on them was ever rewarded by seeing them again so extended.

At first glance it might be thought that we had here to do with another Gromia, but several characters seem at once to exclude our form from a place in that genus. First, the test

is not membranous, but built (if so loosely and irregularly constructed a domicile can be said to be built) of foreign particles. Again, the pseudopodia, though they often copiously branch, do not seem to inosculate, nor to carry a stream bearing along granules, but the pseudopodia are clear and silvery in appearance.

For so far, however, whilst our animal offers resemblances to several other allied forms, as well as distinctions from these, upon both of which I shall presently briefly touch, it presents still another characteristic (as I previously mentioned) which seems to be unique. I allude to the fact that from the whole of the surface of the inner sarcode body, except the anterior prominence, there are given off exceedingly numerous, very short, linear, hyaline, unbranched pseudopodal processes, of but slightly varying lengths, which protrude through the loosely connected outer covering, and there, when seen marginally, looking like a dense fringe, bordering the body all round. Here, then, we have a rhizopod presenting the seemingly remarkable character of one and the same sarcode body giving off its processes of two distinct forms or kinds—one often long, copiously branched, and very transitory and fitfully changeable—the other short, unbranched, and so comparatively rigid as to give the appearance of a persistent hyaline marginal fringe; the first kind confined to one end, which I have called the anterior end of the rhizopod—the second kind evenly and densely distributed everywhere else.

I am not aware, then, that the circumstance just alluded to has a parallel amongst Rhizopoda, and hence I cannot but think such a form demands a distinct genus for its reception. It is true that I myself have drawn attention in a previous part of this paper (*antè*, p. 267) to two congeneric forms, themselves forming the type of a new genus, Heterophrys, and otherwise, indeed, considerably removed from our form, but which present sarcode processes of two distinct kinds, but each of these emanate from a differentiated part of the sarcode body, one enclosed within the other, and are not, as here, given off from one and the same body, seemingly without any differentiation, if I might so express it, of its body structure.

But amongst Rhizopoda provided with a test, and not of the radiate (heliozoan or radiolarian) type, our form presents what appears to me to be still another speciality. That such a form should present an internal contractile vacuole would not be unusual, but that it (in some of the specimens, at least) should offer a marginal pulsating vacuole, similar to that of an Actinophrys, seems to me to be noteworthy. Such, at least, so far as I am aware, has not been seen in Difflugia or

Gromia, for instance, from both of which, indeed, our form upon other characters is sufficiently and distinctly removed. Perhaps, however, I err in ascribing any particular importance to such an organization in our form, but, at least, such is one of its characters. In the drawing (Pl. XX, fig. 6) I have tried to depict the pulsating vacuole at its extreme point of distension just before its discharge and collapse in that wrinkled and contracted manner with which every one who has seen the same phenomenon in Actinophrys or in Actinosphærium must be familiar.

The body-mass of our form is rather densely granular, and thereby rendered somewhat opaque. Immersed in the substance can be seen, without much trouble, however, a large and globular body, the so-called nucleus. With a little pains this can be pressed out intact, and is seen to be of that granular character and somewhat bluish hue of the similar body in an Amœba, the body substance bearing opaque, somewhat coarse, and crude-looking granules.

Having thus endeavoured to convey an idea of this new form, I shall below contrast it with those few which seem to come nearest it, or for which it might be mistaken, and thereby, perhaps, overlooked, even though it should be encountered elsewhere by other observers. I need hardly say, however, that the fringe-like emanation of pseudopodal processes in conjunction with the anterior, long, and branched ones, would alone seem enough to distinguish the present form from any other. I have thought that the generic name Diaphoropodon calculated to express this speciality, and name this curious form accordingly *Diaphoropodon mobile*, reserving short generic characters for the present. The resemblances which this form presents are, of course, apart from the circumstance alluded to. Leaving, then, the body processes out of view, the most immediate allies of our Diaphoropodon are seemingly forms which appear to appertain to Pleurophrys (Clap. et Lachm.), represented by the three drawings (Pl. XX, figs. 1, 2, 3), and Amphitrema (nov. gen., Pl. XX, figs. 4, 5), to which I would briefly advert in the next following section of the present communication.

Notes on Certain Fresh-water Species *of* Diatomaceæ.

By A. S. Donkin, M.D.

The late Professor Smith, in referring to the genus *Epithemia* in his 'Synopsis of the British Diatomaceæ' (vol. i. p. 11), observes that "this genus, as its name implies, is

characterised by the adherence of its frustules to Algæ of larger growth. This character is true of most of the species, and even where not strictly applicable, as in *E. gibba* and others, we detect a disposition to rely on a foreign body for support, their frustules being usually embedded in the mucus of some member of the family Palmellaceæ." Recently I have had an opportunity of ascertaining that *Epithemia gibba* is strictly an adherent species, and that its supposed exceptional character in this respect has been based on insufficient observation.

In the month of August last, when on a visit to Sir Walter Calverly Trevelyan, Bart., at his seat at Wallington, in the heart of Northumberland, I observed in a large pond of clear water near the mansion an abundance of the greater bladderwort (*Utricularia vulgaris*) growing erect in the water. As the leaves and stems of this plant presented a cloudy appearance, characteristic of parasitic growths, I subjected them to a careful microscopical examination, and found that the appearance alluded to was produced by an abundance of adherent Diatomaceæ, the species being, *Epithemia gibba*, Ehrb.; *Epithemia ventricosa*, Kütz.; *Epithemia granulata*, Ehrb.; *Epithemia Sorex*, Kütz.; *Synedra capitata*, Ehrb.; *Cocconema lanceolatum*, Ehrb. All were exceedingly abundant, and it was an interesting fact to observe that *Epithemia gibba* and *E. ventricosa* were attached, by one extremity, not by the ventral surface of the frustule, as is the case with the other members of the genus. *E. gibba* thus shows an affinity for the genus *Synedra*, being in other respects somewhat aberrant in its characters, and by no means typical of its own genus.

Epithemia ventricosa, Kütz., I feel satisfied, is a small or undeveloped form of *E. gibba*, with which it agrees in every respect except in being very much shorter. In the Wallington gathering frustules are plentiful of every size between the two forms, and show the gradation between them. Grunow has expressed his belief in the identity of the two. With this view I fully concur; and, although Rabenhorst believes them to be widely different ('Europ. Diatom.,' p. 65), I feel assured that *E. ventricosa* should no longer rank as a species. The two forms are generally found associated in the same localities.

It is a somewhat curious fact that immediately after self-division in *Epithemia gibba* the newly formed valve of each frustule is quite linear, and without the gibbous middle it afterwards assumes. Kützing has delineated this peculiarity both in the larger and smaller frustules ('Bac.,' pl. iv, 22, and pl. xxx, 9, *b*). *E. gibba* is subject to considerable varia-

tion of outline. I have in my possession a slide of it, from the collection of the late Professor Walker Arnott, with the frustules almost linear, not at all inflated in the middle, nor at the extremities, but tapering slightly from the middle to the gently rounded extremities. This is the *E. parallela* of Grunow; it is a mere variety, however, and not a distinct species.

Rabenhorst (loc. cit.) describes *E. gibba* as a fresh-water and marine (!) species, and *E. ventricosa* as fresh-water and sub-marine. But actual observation has convinced me that it is strictly a fresh-water form, and parasitic on aquatic plants in clear still water. That its frustules should be found in the mud of tidal estuaries, mixed with marine and brackish water species, may reasonably be expected; but it is never found living, so far as my observation goes, in salt water. Indeed, long and ample experience has satisfied me that fresh-water diatomes are never propagated in water impregnated with salt, as are the tidal estuaries of our rivers. The converse holds good with brackish water and marine species, which are never found in springs, lakes, ponds, or streams completely removed from tidal impregnation.

The jelly-looking flakes floating on the surface of the same pond at Wallington were also exceedingly rich in Diatomaceæ, being composed of *Pleurosigma attenuatum*, Sm.; *Cymbella Ehrenbergii*, Kütz.; *Amphora ovalis*, Ktz.; *Pinnularia Dactylus*, Ehr.; *Campylodiscus noricus*, Ehr. = *C. costatus*, Sm.; *Cymatopleura solea*, Sm.; *C. elliptica*, Bréb.; and *Surirella* (*Cymatopleura*) *plicata*, Ehr. ('Microgeo.,' T. xv. A., figs. 50, 51), very large and fine. A figure is given in Dr. Carpenter's work on the 'Microscope' of this last species (p. 313, 4th ed.), copied from Ehrenberg. Specimens of this form occur in the gathering in every stage of gradation between Ehrenberg's figures and Professor Smith's figure of *Cymatopleura Hibernica*, which seems to have been delineated and described from small specimens slightly contracted below the extremities. There can be no doubt that the two forms are one and the same species, which ought, therefore, to be designated *Cymatopleura plicata*, Ehr. The extremities of this species seem to be subject to considerable variation, such as is witnessed in different specimens of *C. solea*, Sm., and led him to constitute a new species of the apiculate specimens, *C. apiculata*, Sm.—a distinction which ought never to have been made. I cannot agree with Mr. Ralfs ('Brit. Inf.,' p. 793) and Rabenhorst ('Europ. Diatom.,' p. 60) in referring *C. plicata* to *C. elliptica*. In none of my own gatherings, except from Wallington and the River Coquet at Elyhaugh, have I ever met with *C. plicata*. In

both these localities *C. elliptica* also occurred; indeed, the latter and *C. solea* are found in most fresh-water gatherings, both being exceedingly common. If these observations, then, are correct, *C. apiculata* and *C. Hibernica* of Professor Smith must be struck from the category of species.

I would here venture to suggest to those who are investigating the diatomaceæ, the importance of studying them in their natural habits, and of obtaining them there for examination in the living condition. The mud of tidal estuaries should, as much as possible, be avoided, it being the receptacle for all kinds of species—fresh water washed down from the mountains, as well as marine washed up from the sea. The leaves of aquatic plants, especially if filiform, like the Bladderwort and Water Ranunculus in clear still water, should always be subjected to a microscopical examination on the spot, if possible; if not, portions should be brought home in bottles filled with water. The attachment of many of the adherent species, such as *Epithemia gibba*, is exceedingly brittle; great care, therefore, should be exercised in drawing the plants to which they adhere from the water. The force of a strong wind on water not too deep will detach and scatter them floating about as free individuals—a circumstance which has caused the real character of many species to be overlooked.

From the pond at Wallington I obtained a large supply of adherent species by getting into a boat and providing myself with a large wide-mouthed pickle bottle, which I filled with water and placed on one of the seats. I then carefully cut off a stem of the bladderwort, drew it gently from the water, and holding it by its lower extremity dropped it into the bottle, in which it was roughly twisted about and gently pressed between the fingers in withdrawing it from the bottle again. By treating a succession of stems in the same manner the water soon became quite thick and brown looking from the immense quantity of Diatomes collected; the surplus water was easily got rid of by allowing the bottle to stand for awhile; the Diatomes soon settled down to the bottom, and allowed the water to be poured off. The collector will find this a much more satisfactory method of gathering than by poking amongst aquatic weeds with a small bottle attached to the end of a stick.

NOTES AND CORRESPONDENCE.

Resolution of Nobert's Lines.—We have to acknowledge the receipt from the United States Army Medical Department of a further series of most beautiful photographs of Nobert's lines, in which the nineteenth band has been resolved satisfactorily. We shall be glad to make these useful in any way to our correspondents who are interested in the subject.

New Test-object.—I beg to describe to microscopists a new test that I have discovered by accident. In the locality of Dakar Bango, a little town near St. Louis, in Senega, may be found two sorts of spiders; one, the Epeira, forms a cocoon which can be nearly as easily wound as that of the Bombix of the mulberry. The silk, of a beautiful yellow colour, has the aspect of ordinary silk, only it is much finer and less rough. The other spider, known in its native country under the name of "the long spider," also forms a cocoon, but, as in the first, the silk cannot be wound, for the threads are not only bound together one with the other, but they are fused at regular distances by means of a viscous matter which the spider secretes among its work. This gives the cocoon great solidity and much elasticity. This cocoon resembles a band of thick wool; nevertheless, seen under the microscope, its threads could never be confounded with those of wool, although in the country they are given this name. Here, then, are the peculiar characteristics of this last-mentioned substance, which is nothing but veritable silk, whatever be its apparent nature. It is *striated* in the direction of its thickness, exactly as muscular fibres are. With a small power some of the threads only appear striated, and the others are plain; but with a power of 600 diameters striæ may be seen on half those which appear in the field of the microscope. A still higher power is required to define the striæ of the remaining threads. These are, in fact, the threads of the silk of the "long spider," which I beg to propose as a new test for microscopists, and I have a cocoon at the disposal of those wishing for specimens.—MOUCHET, Rochefort-sur-Mer.

Some Remarks on Dr. Donkin's recent Paper on Diatomaceæ.—The binocular microscope resembles the stereoscope only in one particular, namely, that it is an optical instrument to which both eyes are applied. In the stereoscope the

observer looks through *two* lenses at two photographs of some solid body, or of some landscape taken from slightly different points of view, and thus the same impression is produced upon the brain as when the real object is viewed by both eyes. The microscopist who uses a binocular instrument sees *one* magnified image of an object, the rays proceeding from which are so refracted by the intervening prism as to enter both eyes as if direct from the image. It is evident, then, that these two instruments are not similar, and that any theory founded upon their similarity is false. The one image formed by an objective cannot by being separated into two acquire new relations to the figure of the object. It is true that what is called a stereoscopic effect is to a certain extent produced by the binocular instrument. But if two common *cartes de visite* of the same person are placed in a stereoscope, a stereoscopic effect will be produced, and yet the conditions required for forming the pictures correctly, namely, that they should be taken from two different points of view, have not been satisfied, and it therefore follows that the impression produced upon the brain is not accurately true. This case is somewhat similar to that of an image of a microscopic object viewed by both eyes at the same time with the aid of a prism. It is quite possible that the effect of the binocular would be to exaggerate the deviations in altitude on the surface of an object. Dr. Donkin's remarks in his late paper go to establish the truth of these views. He says, 'Mic. Journ.,' New Series, No. xxxv, p. 289:—"Mr. Ralfs, too, whose accuracy as an observer is sufficiently well known, says of the genus Hyalodiscus, 'Its flat disc will distinguish it from Podosira.' Now, the fact is, that the valve of *Hyalodiscus subtilis* is *hemispherical* approaching indeed to *conical*, not a *flat disc*, as it appears to be under the monocular." Now, if this were the case, it must have been detected by the changes of focus necessary to bring the different lamina into distinct vision when using lenses of high power and large angular aperture. Dr. Donkin does not appear to have tried this, but merely to have taken for granted that the binocular must be right, and the monocular wrong. As the effect of the former depends on a kind of illusion, some proof is necessary that the illusion may not occasionally lead to delusion. Dr. Donkin's name is well known in connection with Diatomaceæ, and he may very possibly be adequate to the arduous task which he has undertaken of issuing a new classification of these interesting forms, but it is to be hoped that he will not be guided in his work by observations taken with a binocular instrument.—F. G. Stokes, M.A.

REVIEWS.

What is Microscopical Science?[1]

Some of our friends have occasionally asked, not without the faint shadow of a sneer, "What is microscopical science?" Others have limited it for us to knowledge of things pretty when placed beneath a magnifying power; and many have declared that, at any rate, it is not a sufficient basis on which to rear a scientific journal. The history of our own periodical is sufficient to give a practical denial to the last opinion. We would not pretend for one moment that microscopical science should have a place in Comte's 'Classification of Sciences'; nor do we suppose that it can be regarded as a philosophical division of knowledge at all. Such a consideration is, indeed, of very little import in the actual affairs of literature or science. The particular branches of study to which we find individuals devoting their lives do not, by any means, indicate divisions of science which would be recognised as legitimate by any philosopher; nor does microscopical science claim to be more than such a branch, furnishing us with a term of eminent practical utility. By microscopical science we understand the knowledge gained by intelligent use of the microscope in the investigation of various forms and structures, whether animal, vegetal, or mineral. It is undeniable that there is a certain range of subjects in which all who know that glorious instrument feel an interest. Those who have once enjoyed the gift of a new sight do not readily lay it by, but advance in the use of their new power, and apply it to the many and various things within reach. The anatomist who has been tempted to seek the aid of the microscope in his investigations of human structure does not lay it down content with the study of microscopic anatomy, but soon finds himself deeply engaged in tracing the many forms of minute life which are to be found so abundantly by aid of the instrument. We could name many a distinguished man who has thus devoted him-

[1] 'Molecular and Microscopical Science.' By Mary Somerville. Two vols. London: Murray.

self, not only to minute anatomy, but also to minute zoology and botany—in fact, to microscopical science. It is the instrument which has directed the course of these men's study, which has charmed them, and led them on from field to field, which has made them pathologists, anatomists, zoologists, and botanists at the same time. Is not then this great power—the microscope—a fair standard to have raised? We feel sure that now, as heretofore, microscopical science has its ever increasing army of enthusiasts, and that to a large body of educated men the chronicle of the daily conquests made through the microscope, whether belonging strictly to this or that domain of knowledge, must have a true and deep interest.

Microscopical science assuredly includes many subjects which require that some attempts at grouping them should be made, and we offer the following as a useful division:

A. *Subject-matters.*
   1. Histology—Animal, vegetal, and mineral.
   2. Embryology—Animal and vegetal.
   3. Microzoology, microphytology, micromineralogy.
   4. Cell-diagnosis and minute characteristics of plants, animals, and minerals.

B. *Forensic and technical applications.*

C. *The instrument.*
   1. Essential apparatus.
   2. Accessory apparatus.

Histology—as it is generally understood.—*Human* histology is undoubtedly the most important department of Microscopical science, from a practical point of view. Great results have been achieved already, and still greater are to be looked for. Long and patient as have been the observations of both foreign and British workers there is still much confusion, much contradiction, much ignorance to be accounted for and corrected, in the results announced from various sources. Form has been studied to the neglect of substance, and it is from the prosecution of *chemical* researches on the tissues, aided by the microscope, that we may hope for the most important additions to knowledge. The nature of the cell, the existence of contractile vacuoles and canals, declared by Balbiani to be present in some cells, the simpler structure of others, the existence of structureless protoplasm in the human body, the physical properties and origin of cells, require renewed investigation and the application of improved methods of research. The action of cells in relation to the

formation of intercellular substance, the question of "conversion" as against "excretion," is of the highest interest, and remains for further discussion. Our great observer in this country, Dr. Lionel Beale, has enunciated views on these subjects which deserve the most careful study of his fellow-countrymen. We are too apt in England to overestimate what comes from Germany, and some advanced philosophers are unwilling to accept the teachings of a believer in "a vital principle." Such matters as the latter ought not to influence the judgment as to *facts;* and as to the former, a distinguished naturalist from Leipzig not long since told the writer that Englishmen believed too much in German work, and were ridiculed in Germany on that account. We ought not to mistake quantity for quality. Where so *much* is done *some* will necessarily be good; but one has only to read the contradictory statements of eminent men, such as Kuhne, Kölliker, Brucke, and others, on such matters as nerve-termination, to feel convinced that the work done is not *all* sound. The system, too, which prevails in Germany of students working out some detail for their professor, and enunciating his views far and wide on the most trivial matters, tends greatly to the glorification of German histologists, and the appropriation of the observations of other men by the process—"A has suggested this, and I confirm him;" "A and I have shown this;" with finally, on the third occasion of reference, or in a third edition of some work, "*I* have shown this"—a process not unknown to one distinguished German writer at least—is a method of gaining a great reputation which is in use. The gradual but certain triumph of true views, and the inevitable, though sometimes tardy, justice which will be done to their originators, must console us sometimes for present misapprehension. We point with satisfaction to the history of the discussion as to the termination of the nerve in muscle, exhibiting as it does the gradual acceptance of facts carefully and quietly, and, without doubt, originally worked out by Dr. Beale. In a recent publication Dr. Maddox has very fully confirmed some of Dr. Beale's observations; but it is in the lectures[1] and demonstrations lately given by Dr. Beale in the University of Oxford that the latest exposition of his views will be found.

It is worth noting here that the structure of the tactile corpuscle, as lately described by Professor Rouget, of Montpellier, was long since indicated by Dr. Beale in one of his numerous papers.

The histology of the lower animals, especially of the in-

[1] See Report in the 'Med. Times and Gazette.'

vertebrate groups, has been very little studied at all by observers in this country. Most earnestly do we commend this study to those of our readers who wish to make their microscopes useful in the cause of science. Franz Leydig, of Tubingen, has devoted more attention than any other observer to comparative histology; and his valuable 'Lehrbuch,' filled with excellent woodcuts, is the best guide a student can have in this subject.[1] Insects, molluscs, worms, all furnish subjects of study most important in their bearing on the histology of man and the vertebrata.

The histology of minerals may appear to some persons a curious association of terms. But, assuredly, the complex substance of a mineral may be spoken of as a "web"; and the far-known researches of Sorby on the glass-cavities of crystals, and other matters relating to their origin and structure, lay the foundations of a mineral histology.

The *Embryology* of plants and animals form a distinct and perhaps the most important branch of microscopical science in relation to all other knowledge, for without the microscope our knowledge of embryology would be *nil*, and without embryology we may fairly doubt if ever that grand doctrine of evolution which Herbert Spencer has taught would have been developed and laid its hold on men's minds. In this country there is great want of a knowledge of embryology in general. In no manual or book of any kind in the English tongue is the development of invertebrates and of vertebrates treated in detail; so that the student who would desire to aid in the solution of the many problems of the early development of Arthropods or Molluscs finds it difficult to gain a starting-point. The memoirs of Dr. Edouard Van Beneden and of Dr. Emile Bessels — the former of whom studies the formation of the blastoderm, the latter its subsequent changes—will be found of great value. Dr. Van Beneden has studied the early changes of the ovum in all classes of animals, and is now about to publish his results. The memoirs of Mecznikow on the development of Hemiptera and other insects are of the greatest value, but are not so accessible to English readers as French publications. A volume on "Development," from the pen of Dr. Michael Foster, of University College, has long been looked for, and may be expected to contain a well-considered account of the embryology of all animals as far as the latest researches have gone.

By *Microzoology*, *Microphytology*, and *Micromineralogy* in our list above we mean the study of minute organisms or

[1] A French translation of the work is published by Baillière.

minute crystals, rather than the study of organisms or minerals minutely. It is difficult to draw the line round "microscopic organisms," and exclude this, and include another group; but it is not necessary to do so. The Protozoa and the smaller Cryptogamia undoubtedly form the nucleus, and we may add the Rotifera, many Worms, and many Crustacea. The papers of Ernst Haeckel, of Jena, one of which we publish herein, should give a new impulse to the study of minute forms of life. The determination of Bathybius[1] by Professor Huxley must lead to further observations of a similar kind, and we may hope to find these structureless protoplasmic masses in many and widely different situations. One very important and pleasant result to which they tend is the shelving of the reiterated doctrines of the old school of heterogenists. These persons have pursued the course of science with great pertinacity, always declaring that they could prove the spontaneous formation of the lowest organisms known to science, whatever they might be at the particular time. At one time it was maggots, then the vinegar eel, then ciliated Infusoria, and, lastly, Bacteria, which the successive generations of these headlong philosophers adopted as "spontaneous" productions. A thoughtful man, disposed to believe in the possibility of the production of living from mineral matter without the intervention of previously organized matter, is driven in to holding his tongue in the presence of these enthusiastic experimenters, lest he should be supposed to believe in *their* untenable dogmas. Whilst we could not believe in the production of such definitely-formed organisms as Bacteria and Vibriones by a great bound from mineral to vegetable—a method of progression which the oldest philosophers denied to nature—we can conceive that by very gradual steps the mineral matter may become like that which we call organic, and finally become organized and of definite form. *Bathybius* helps us a step or two downwards in the mineral direction—so far, that the experimental heterogenists must now form slimy sheets of protoplasm in their decoctions and hermetically-closed reservoirs, or must explain how it is that "spontaneous generation," as they believe it, starts high up in the scale of life.

The parasitic or fungus origin of many diseases belongs to this branch of microscopical science, and we may here call attention to Professor Hallier's views elsewhere noticed more fully in this Journal. It appears, from the report of a commission sent to visit the professor at Jena, that the power

[1] See his paper in the October number, 1868.

he used in studying his parasites characteristic each of its disease magnified only 250 diameters, and that the methods of isolation were incomplete. But he was a German, and so the English believed in him at first. The Rev. M. J. Berkeley, who is probably a sounder observer, but who has not caused so much 'sensation' as Hallier, also studied the subject of the fungoid origin of disease, and in his address at Norwich[1] he expressed the opinion, based on his great knowledge, that Hallier had gone farther than the facts warranted, and was simply wrong. Most people are swinging back (like the pendulum) to this opinion, although we hear occasionally of remarkable confirmations of Hallier's views from America and elsewhere.

Cell-diagnosis in plants has yet to be made of its full value. Professor Gulliver has studied the Raphides in many, and shown how far they furnish characters. He has lately written on pollen-grains, but more remains to be done, especially as to hairs, pollen-grains, and starch-granules, which may furnish important systematic characters. In animals, minute points of structure have been used by the systematist with advantage, and may be still more so. The setæ of Annelids, requiring a good quarter for their proper discrimination, so delicate are their forms, characterise genera and species; the odontophore of cephalous Molluscs, the shell structure of Brachiopods, the blood-corpuscles of the Vertebrata, are examples of structures which furnish important diagnostic characters when studied with the microscope. It is obvious that this use of the microscope has a very different aspect to that of histology. The systematist is not an anatomist, and looks at the differentiæ of structure rather than the relations and resemblances.

Of the *Forensic* and *Technical* aspects of microscopical science we have not now space to speak.

With regard to the instrument, we would most strongly urge the importance of British microscopists fully understanding and appreciating the powers and value of the instruments used in other countries. We mean especially as to the objectives. Colonel Woodward, of the United States Army Medical Department, has done great service for us by comparing many powers in resolving Nobert's lines; but other tests of efficacy besides resolution of lines should be applied if possible. If Nachet's immersion lenses are better, or as good, as the best of our long-boasted English glasses, let us know it and buy them, since they cost about half the price

[1] See this Journal, October, 1868.

paid for the latter ; but we should first be well assured of the comparative utility of the glasses.

The invention of instruments for bringing physical agents, such as heat, light, and electricity, to bear upon objects whilst under observation in the microscope is a subject which deserves the greatest attention. The polariscope, the Sorby spectroscope, Stricke's gas-current, hot-plates, and such apparatus, together with judicious and educated use of chemical reagents, multiply the power of the microscope as a means of gaining knowledge as to the form, composition, and meaning of structure, a hundred or even a thousand fold. It is in this direction that histology must advance, and hence the importance of such apparatus as the above named, which is rarely seen with English microscopes. The study of the action of physical agents on living tissue, on protoplasm, &c., is almost unknown in this country. Would not the Royal Microscopical Society do well to acquire all such accessory apparatus for examination and study by the Fellows? The surplus money of the charter fund would be much better spent in acquiring foreign objectives and little-known apparatus than in the purchase of second-rate, or even first-rate books, which can be seen at any library.

We must now turn to Mrs. Somerville's book, which it was really difficult to do before, for though we hoped to gain some notions on the subject of microscopical science from the perusal of the volume and a half devoted to it, we have not done so. In the first place, let us at once say that the book is a very pretty one, with some nice plates of Radiolaria in blue and white, and many woodcuts, which are good, but not new. The first part, which relates to chemistry, heat, the spectrum, &c., is very readable, true, and appropriately named, corresponding, as we suppose it does, to the part of the title "Molecular." But where is the appropriateness in calling what follows "Microscopical Science"?

Mrs. Somerville gives a good but entirely second-hand account of the lower plants, with a few introductory remarks on cell-structure. The whole of the second volume is occupied with similar abstracted accounts of invertebrate animals—a large share of space being devoted to Radiolaria, which are described after Haeckel—whence we suppose the justification of the term 'Microscopical science.'

We are sorry that Mrs. Somerville has written this book, or rather that part of it relating to organic beings. She is a lady who has attained a great name by her acquaintance with physics ; but it is evident that she does not comprehend biology as well as we believe she does other departments of

science; and though her book is pretty, it cannot be regarded as in any way authoritative. It is, however, vastly superior to Mr. Jabez Hogg's treatise on the microscope in all that relates to zoology, and may, we hope, take the place of that very inaccurate production. We can best illustrate the curious *naïveté* exhibited by the venerable authoress in a quotation. "Numerous instances," she says, "of microscopic structure may be found in the vertebrate series of marine animals, but the field is too extensive for the author to venture upon." True, Mrs. Somerville, numerous, very numerous, instances may be found, and certainly the field is rather a large one. "The life history of the *lower* classes," adds the authoress, a few lines farther on, "of both kingdoms has been a triumph of microscopical science."

We commend these volumes to the reader in spite of the defects mentioned; not their least attraction being that they are from the pen of the authoress of the "Connection of the Physical Sciences."

QUARTERLY CHRONICLE OF MICROSCOPICAL SCIENCE.

Histology. GLANDS.—*The Structure of the Pancreas.* M. Gianuzzi, in a paper communicated to the French Academy, states that the excretory ducts of the pancreas are lined with a very delicate epithelium. Their finer ramifications form a network devoid of epithelium, which encloses the pancreatic cells in its meshes, and may be compared to the biliary network of Hering. The injections by which the structure of the pancreas were determined by M. Gianuzzi were made by the pressure apparatus of Ludwig.

The Connective Tissue of Glands. By Franz Boll. One plate. *Schultze's Archiv.* Bd. V, prt. 3.

On the Alteration of Tissues in the Inflamed Liver By Dr. And v. Huttenbreuner. One plate. *Ibid.*

NERVE.—*Studies on the Structure of the Cerebral Cortical Substance.* By Dr. Rudolf Arndt. Third part. One plate. *Schultze's Archiv.* Bd. V; prt. 3.

The Axis-cylinder-prolongation of the Nerve-cells in the Cerebellum of the Calf. By Dr. A. Koschennikoff, of Moscow. *Ibid.*

The Axis-cylinder-prolongation of Nerve-cells in the Cerebral Cortical Substance. By Dr. A. Koschennikoff. *Ibid.*

BLOOD.—*The Cause of the Formation of the Rouleaux of Blood Corpuscles.* By Dr. Norris, of Birmingham. *Proc. Royal Soc.*, June, 1869. By ingenious experiments Dr. Norris shows the cause of the curious agglomeration to be due to the fact that the substance of the corpuscle is not miscible with water. Gelatine discs wetted and sunk in paraffin completely imitated the action of the corpuscles.

TEGUMENT.—*On Cuticular Growths and the Cornification of Epithelial Cells in the Vertebrata.* By Franz E. Schulze. *Schultze's Archiv.* Bd. V; prt. 3. Two plates.

MUSCLE.—*Histological Researches on the Lower Animals. Koll. and Sieb. Zeitschrift.* 1869, prt. 2. By Dr. Fritz Ratzel, of Carlsrhue. Two plates. This first instalment of a series of papers treats of the muscular tissue of the Oligochœta.

Another Word on the Muscles of Nematodes. By Anton Schneider. *Koll. und Sieb. Zeitschrift*, prt. 2. 1869.

General.—*The Histology of the Cœciliæ.* By Franz Leydig. *Köll. u. Sieb. Zeitschrift*, xviii, p. 575, noticed in the *Archives Suisse*, No. 139.—The little group of Cœciliæ offers so many remarkable peculiarities in its zoological aspects that the essentially histological treatise of Dr. Leydig deserves great attention. His researches were conducted on two species, the *Cœcilia lumbricoidea*, Dand., and the *Cœcilia* (*Siphonops*) *annulata*, Mikan. The structure of the integuments of the Cœciliæ, excepting the scales existing in some species, agrees with that of Batrachians in general. The nature of the epidermis was, it is true, long misapprehended. Led by Mikan, many authors saw in it nothing but a mucosity secreted by the cutaneous pores, or even by the anus.

This error recurs even in the beautiful work of Johannes Müller on the anatomy of Amphibia. Rathke was the first to recognise in the supposed mucosity a true epidermis. Dr. Leydig now finds the epidermis to be covered in by a distinct homogeneous cuticle, and it is reflected into the numerous excretory canals of the cutaneous glands. The scales first discovered by Schneider have been much discussed by naturalists, the more so because they are entirely absent in all other living Batrachians. One species, *C. annulata*, is completely devoid of scales. The histological study of *Cœcilia lumbricoidalis* (sic) has proved to Dr. Leydig that the deep layer of the scale is formed by a solid, stratified connective tissue, filled with stellate cells. Its superior surface is ornamented with brilliant corpuscles, disposed in rather irregular concentric ranges. M. Mayer calls them globules, M. Mandl cellules; they are, in reality, calcareous concretions.

The skin of the Cœciliæ presents a laminated structure, already mentioned by many authors. This structure is due to numerous cutaneous folds, in the thickness of which are lodged the glands. The scales are placed between these laminæ. They are not by any means free, but are attached to the corium by a delicate connective tissue.

The eyes of the Cœciliæ are deserving of special attention on account of their rudimentary condition. The *Cœcilia annulata*, although living at a depth of several feet in the mud of marshes, has, nevertheless, very small ocular bulbs. These bulbs correspond to a transparent place in the skin, and present all the essential parts of a normal eye. The crystalline lens, however, retains its embryonic character; in fact, it is formed, not of fibres properly so called, but of cells, some rounded, some elongated into tubes. The muscles of

the eye, to the number of four, are attached to the sclerotic. The Harderian gland is relatively very large. Although zoologists are right in attributing to *Cœcilia annulata* the character *oculi minuti;* they go too far when they say of *C. lumbricodea* "*oculi nulli.*" They ought to be content with saying *oculi minutissimi.* The eyes are, in fact, always present, although extremely reduced in size. No crystalline is present in this case, and the gland of Harder is enormous. It is the same in the blind serpents, Typhlops, where Duvernoy has described a lachrymal gland six times as big as the ocular bulb.

Dr. Leydig has paid special attention to the singular organ mentioned by authors sometimes as the "false nostril," sometimes as the "lachrymal cavity." By this is understood a cutaneous pore conducting into a canal which is directed obliquely towards the eye. Joh. Müller recognised in the interior of this canal, in different species, a tentacle, or tongue-shaped papilla.

Leydig confirms the existence of this organ; he finds, moreover, that from the wall of the cavity in *C. annulata* two tubes take their origin, joined one to the other, and which one might at first mistake for vessels. Their walls have no muscular fibres, but are composed entirely of very fine fibres of connective tissue. These two tubes reunite at the opposite extremity, forming a loop. An analogous organ exists in the *Cœcilia lumbricoidea.* The functions of this apparatus are quite obscure. One might suggest that we have here an organ of special sense, comparable to the "mucous canal" of fishes; but the essential character of an organ of sense—viz. a peripheral nervous structure—appears to be wanting.

The Cœciliæ present points of affinity with fishes and with scaly reptiles, though essentially amphibious. They are the remains of a group of Amphibia, formerly richly developed, which must have branched off from the fishes with the Amphibia in the carboniferous epoch (Archegosaurus). The affinity of the Cœciliæ with fishes is seen in the structure of the bodies of the vertebræ, in the nature of the scales, and their disposition in cutaneous pouches. The kidneys, too, of these animals have been compared to those of fishes. Dr. Leydig does not agree to this assimilation. The kidneys, he considers, have the same structure as in the other Amphibians —they remind him of the kidneys of the Ophidia. The affinity with Ophidia is carried out, not only in general form, but in the dentition and in the atrophy of one lung.

The affinities with Amphibia are established by the rich

ness of the skin in glands, the structure of the hyoid bone, the double occipital condyle of the skull, the rudimentary ribs, the branchiæ in the young. Lachrymal glands are entirely absent in fish, but present in Cœciliæ. The "false nostril" is either homologous with the cephalic fossa of Ophidians or is a special organ.

Embryology.—*Researches on the Development of the Chætopoda.* By Edouard Claparède and Elias Mecznikow. *Kolliker's und Siebold's Zeitschrift*, vol. xix, prt. 2.—During a residence at Naples in the winter of 1866-67, the two distinguished observers whose valuable paper we have before us, had an opportunity of studying the development of many species of Annelids, and of filling up some of the many lacunæ by which this subject is as yet marked. The method of their researches was various, although not new. By means of the towing-net many larvæ were obtained and watched for various periods in their development. Masses of the ova, together with the mother-worm, were also in some cases obtained and hatched in vessels, whilst some species deposited their ova which developed in the aquaria which the observers kept. The authors do not consider all the larvæ which they observed as worthy of further notice; they have confined their illustrations, comprised in six coloured folding plates, to those of which they could determine the species, or at any rate the genus, with certainty. As a general result it appears that the division of Annelid-larvæ into several groups—such as has been essayed by Busch, Joh. Müller, and Claparède himself—has but a very subordinate importance. The names Atrochæ, Telotrochæ, Polytrochæ, Mesotrochæ, Nototrochæ, Gastrotrochæ, &c., indicate only transitory conditions, and if adopted we should have often to group the larvæ and the adults in incongruous assemblages. Thus many Terebella-larvæ are true Nototrochæ, others develop bands and circles of cilia; whilst many larvæ of Eunicidæ are really Polytrochæ, others, on the contrary, are Atrochæ in Müller's sense. This dissimilarity in the larvæ of very closely allied Annelids should excite no surprise, since the development of bands of cilia, or of continuous ciliated tracts for locomotive purposes in these early stages must depend on the free or confined nature of the life to which the larva is to submit during development. Thus the Terebella-larvæ of pelagic habit are regular Nototrochæ, whilst the larvæ of other Terebellæ never go far from the egg mass, and the ciliated tracts are proportionately deficient: according to hitherto received principles these various Terebella-larvæ would be classed in very

different groups, which is sufficient to illustrate the incorrectness of the system.

The first stage of development in all Chætopods appears to be very similar, the yelk division has as yet been followed out in all its stages in but very few species. Sars in Polynoe, Milne-Edwards in Protula, and Quatrefages in Sabellaria, have given great attention to this matter, and the results obtained by MM. Claparède and Mecznikow accord very well with theirs. In all Chætopods the division of the yelk proceeds so as to produce two kinds of yelk elements, which differ chiefly from one another in point of size and consistency. From the commencement of the process of division this distinction takes its rise, for the yelk is at the very first divided into two unequal portions. The smaller of these portions proceeds in its division much more rapidly than the larger, so that at length you get a number of small balls or cells (the result of yelk division) enclosing larger masses or balls. The larger enclosed yelk balls are destined for the formation of the digestive tract; the smaller peripheral cells serve, on the other hand, for the development of the body walls, the muscles, and the nerve system. Thus, in the recognised language of embryology, we may call the one yelk mass the *vegetative*, the other the *animal*, layer. In this respect we have a very welcome agreement between the process of yelk division of Chætopods and Leeches, the latter having been well established by the concurrent observations of Grube, Leuckart, and Robin. With regard to the so-called polar cells or Polkugeln, the authors have not much to say. Their appearance seems to them to be quite irregular, and in many cases they are entirely wanting. The fate of the germinal vesicle is, the authors observe, a puzzle to them. In many species it seemed to disappear entirely upon fertilization, and by no method could they bring it again into view. In some species, the eggs of which became very dark after fertilization, there was indeed an appearance which is peculiar to many Annelids, and which was noticed by Quatrefages in Sabellaria. But by no contrivance or use of reagents could the authors succeed in bringing to view a vesicle among the yelk granules. It is noteworthy that in this case the first masses resulting from yelk cleavage were equally devoid of nuclei.

In the unmistakable approximation of the Chætopods to the Arthropod-type the absence of a ventral cellular band (Keimstreif) has been hitherto a very remarkable fact, since this structure is so characteristic for Arthropods. The strangeness was increased by this, that the presence of a ventral band (Bauch-streif) has been well established in the

embryos of other worms; for instance, the leeches. Certainly the development of the structure in question is so different in the two cases, as Leydig has rightly remarked, that one can only trace out the resemblance with the primitive streak of Arthropods through the similarity of the metamorphosis. The strange and unlooked-for thing consists in this, that the primitive streak develops itself in the leeches on an embryo, which all the while is leading an individual life, whilst it is in the other case the still structureless yelk which gives rise to this appearance as the first indication of embryonal structure. That the Chætopods should resemble the Bdellidæ in this respect is no doubt new, but it is scarcely surprising. This fact first became known to the authors through the observation of the embryos of Oligochæta. These last present a much closer similarity with the embryos of leeches than with the developing-stages of Polychæta, a fact which, in view of the many points of contact between Oligochæta and Bdellidæ, is not at all extraordinary.

In all Polychæt embryos the ventral band makes its appearance as a remarkable thickening of the so-called "animal layer" quite unmistakably. But quite as little as in the leeches does this occur in the very first process of embryo-formation; for this thickening often develops itself first when the embryo has begun to lead a free life. At first it is proportionately inconspicuous, but very rapidly it acquires thickness. Much later the ganglia of the ventral cord commence to be differentiated in it. The remarkable thickness of the ventral side has been already described, and figured in many embryos and larvæ, but always without any reference to the ventral band of the Arthropods and Bdellidæ. The difference, then, in the development of Annelids, according as there is the presence or absence of a so-called Bauchstreif (ventral band), ceases to have any importance.

After the introductory remarks, of which we have given the substance above, MM. Claparède and Mecznikow proceed to describe the larvæ of *Spio fuliginosus*, Clprd.; *Spio Mecznikowianus*, Clprd.; *Nerine Cirratulus*, Della Chiaje; *Polydora* (*Leucodore*, Johnst.); *Telepsavus Costarum*, Clprd.; *Phyllochætopterus socialis*, Clprd.; *Lumbriconereis sp.*; *Ophryotrocha puerilis*, Clprd.; *Staurocephalus Chiaji*, Clprd.; *Nephthys scolopendroides*, Della Chiaje; *Phyllodoce sp.*; *Capitella capitata*, Fabr.; *Cirratulus sp.*; *Audouinia filigera*, Della Chiaje; *Terebella Meckellii*, Del. Ch.; *Dasychone lucullana*, Del. Ch.; *Spirorbis Pagenstecheri*, Qtrfg.; *Pileolaria militaris*, Clprd.

On the early stages in the Development of Phyllodoce maculata. By W. C. McIntosh, M.D. *Annals and Mag. Nat. Hist.*, August, 1869.—Dr. McIntosh hatched the eggs of this species, which he kept in an aquarium. His observations relate to the early stages before any segmentation has begun to manifest itself, and agree very well with those recorded in the paper above on a species of Phyllodoce.

Microzoology.—*Remarks on Acanthocystis viridis*, Ehbg. By Dr. Grenacher, of Wurzburg.—This is one of the actinophryoid Radiolarians of which Mr. Archer has done so much to extend our knowledge in the pages of this journal. Dr. Grenacher gives a very excellent drawing of the species, which he has studied with great care, and his description is clear and detailed. He remarks very happily that, from a Darwinian point of view, we may consider these freshwater simpler forms of Radiolaria as bearing the same relation to the more elaborate, and vastly more numerous, marine forms of the group, which the little freshwater hydræ bear to the great group of hydroid polyps inhabiting the sea.

The Anatomy of the Bed Bug. By Leonhard Landois, of Greifswald. *Koll. und Sieb. Zeitschrift.* Prt. 2 (1869). Plates.

Miscellaneous.—British Association.—*Further Observations on Dendroidal Forms assumed by Minerals.* By Dr. Heaton, of Leeds.—The object of this communication was to draw attention to the peculiarities of the dendroidal forms developed upon some purely mineral crystals when immersed in a weak solution of silicate of soda, and to make some additions to the observations upon this subject read at the meeting of the Association at Dundee in 1867. As was then pointed out, when crystals of sulphate of iron, sulphate of copper, or some other salts, but preferably sulphate of iron, are immersed in a dilute solution of silicate of soda, in the course of a few hours branches, exactly like those of some vegetation, shoot perpendicularly upwards, being straighter in a rather stronger solution, more contorted, and sometimes distinctly spiral, when the solution is somewhat more dilute; though it is only within certain limits of dilution that any satisfactory result can be obtained. The trunks of these mineral vegetations occasionally ramify and subdivide, and sometimes two parallel branches, after growing side by side for a time, will again unite or anastomose with a single trunk. At their base, those developed on sulphate of iron may have a diameter of $\frac{1}{10}$ inch; as they elongate they gradually become narrower, ultimately terminating in fine needle-shaped extremities. Dr. Heaton had stated at Dundee his opinion that the

terminations of branches *still growing* are, in pointed extremities, carried forwards as growth proceeds, necessarily implying (were this so) an *interstitial* mode of growth; but having since made an arrangement by which branches may be microscopically observed whilst in process of growth, he must now correct that statement. A growing branch has already its full diameter, but as it elongates, and the power of growth becomes enfeebled, it gradually narrows, and when the needle-like point is formed there is no more elongation. The extremity of a growing branch, as seen under the microscope, appears enveloped by a slight cloudiness in the liquid, which is gradually lifted up so as to precede the growing point; and the continuous elongation of the branch presents a very curious appearance. The branches are delicate tubes, having thin, semi-transparent walls; they collapse and fall in pieces when taken out of their native fluid. Under a high power of the microscope they present a finely granular structure, but not any trace of crystalline form. Both the silica of the solution, and the constituents of the crystal on which they grow, enter into their formation. The nature of the force which determines the assumption of a dendroidal form, and a tubular structure by these confessedly mineral formations, and their upright growth in opposition to the tendencies of gravitation, is neither simple aggregation nor crystallization. It presents certainly a remarkable resemblance to that by which is effected the growth of living tissues, under the influence of vitality, upon which it may serve to throw some light. And, *so far*, these structures seem to form one slight gap (amongst others) in that wall of demarcation by which it has generally been held that the inorganic mineral world is absolutely divided from the world of organization; but here, manifestly, there is no attribute of vitality. In connection with his subject, and as bearing on it, Dr. Heaton also noticed a communication by Mr. W. C. Roberts to the journal of the 'Chemical Society' of last year, upon the occurrence of organic forms in colloid silica as obtained by Graham's process of dialysis. These specimens have all the appearance of microscopic fungi, presenting radiating fibres composed of elongated cells, and bearing fructification, having much resemblance to some common forms of mildew.

Report on the Examination of Animal Substances with the Spectroscope. By E. Ray Lankester.—The report first dealt with the methods of using the spectroscope in observing absorption spectra. A spectrum map of N_2O_4 gas, containing nearly forty numbered lines, had been printed and used by the reporter for recording spectra. The report then

dealt with the following subjects:—1st. Distribution of Hæmoglobin in the Animal Kingdom; 2nd. Some derivatives of Hæmoglobin; 3rd. The Action of Cyanogen Gas on Hæmoglobin; 4th. Chlorocruorin (the green blood constituent of some Annelids); 5th. Chondriochlor, or Sponge-chlorophyl; the Green Chlorophyl-like body found in the cortical substance of Spongilla. It was shown that cyanogen gas-like carbonic oxide and nitric oxide changes the colour and spectrum of a solution of blood-clot, and renders the solution insensible to the action of reducing agents. After keeping for some hours the solution, which has been shaken with cyanogen gas, becomes orange-brown, due to the formation of hydrocyanic acid, and subsequently of the cyanhæmatin of Hoppe Seyler. Chlorocruorin, which has a spectrum very different from that of Hæmoglobin or Erythrocruorin, was shown to yield a spectrum by treatment with cyanide of potassium and sulphide of ammonium, identical with that to be obtained in the same way from Hæmoglobin. Thus the relationship of the two bodies is established.

Spectroscopy. — *The Spectrum of Diatomin.* By H. Smith. *Silliman's Journal*, July, 1869.—Mr. Smith has made use of one of the Sorby-Browning micro-spectroscopes, and has examined the endochrome of the diatom therewith. He says he can "unhesitatingly assert that the spectrum of diatomin is identical with that of chlorophyl." By his own account of the matter he is wrong in so doing, for he has only obtained from diatomin a dark band in the extreme red, which is identical with one presented by chlorophyl under certain conditions. What is ordinarily called chlorophyl gives, however, more than this one band, and it is not right to speak of spectra as "identical" where only one band is found to agree in the two. The fact is, so little is yet really known of chlorophyl spectra, that the term chlorophyl can only be used generically at present. No doubt diatomin belongs to this genus, but the species have yet to be fairly discriminated.

PROCEEDINGS OF SOCIETIES.

Dublin Microscopical Club.

15th April, 1869.

Dr. John Barker showed a good example of the new Rhizopod which Mr. Archer had lately named *Heterophrys Fockii*, believing it to be the same as that brought forward by Dr. Focke, of Bremen, in 'Siebold and Kölliker's Journal.' The present example well showed the marginal pulsating vacuoles of the interior sharply-defined region of the body, a point not dwelt upon by Focke (always supposing this to represent one and the same form), though he had suspected but had not satisfied himself of the existence of a contractile vacuole, not marginal, but immersed in the body-substance.

Rev. T. G. Stokes exhibited specimens of *Amphitetras ornata* from the Seychelles with five points, and of the same species from Guano with four points, thus proving that this is a character of but trivial importance.

Mr. Crowe exhibited an interesting example of the formation of terminal buds on the leaves of an unascertained species of Hypnum, looking, at a hasty glance, almost like some form of Coleochæte living epiphytically thereon. A closer examination, however, showed that those prothalloid structures were really prolongations of the moss-leaves, and merely examples of the very curious simple vegetative mode of repetition which takes place in these plants.

Rev. Eugene O'Meara showed *Surirella elegans* from Lough Morne.

Dr. Macalister exhibited examples of a new louse obtained from the Collared Peccary, *Dicotyles torquatus*. This belonged to the genus Gyropus, and, for comparison's sake, its relative from the Pig (*H. Suis*) was likewise shown. The following characters distinguish the new form called *Gyropus Dicotylis*:—Ferruginous brown in colour; head obtuse, with prominent lateral angles directed forwards, broader than long; last joint of antennæ bilobed, neck $\frac{1}{3}$ of breadth of head; prothorax hexagonal, flattened, separated from mesothorax by a deep fissure, meso- and metathorax not readily distinguished, but separated from abdomen by a slight sulcus; abdomen serrated on margin; hinder pair of limbs long, with curved femur and transversely striated claw; tibia with a projection about its centre.

Mr. Archer, whilst exhibiting a specimen of the dichotomously

branched, brown, flattened, striated production drawn attention to by him at the Club Meeting of December, 1865, would take the opportunity to say that he had little doubt but that it was one and the same thing with the organism named *Aporea ambigua* by Bailey, in his 'Microscopical Observations made in South Carolina, Georgia, and Florida,' p. 42, pl. iii, fig. 3. This, he confessed, should not have escaped him on that occasion, as he had even then Bailey's paper in his possession. The present examples were, however, brought forward for the purpose of exhibiting to those of the meeting, who might take any interest in a thing so common (though not often met in this lively condition), the motion of the somewhat long flagella emanating from the broadened summit of the branches, and waving about with some energy. Bailey, without having seen anything like animal life or motion in connection with this not uncommon production, very shrewdly, however, suggested that it might be the stripes of some attached infusorian, though temporarily or provisionally described as an alga. But it perhaps almost becomes a query, though he makes no mention of flagella or cilia of any kind, whether he means the little fine wavy or zigzag line at the summit of one of the branches in his figure (l. c.) as the expression of any fibrous prolongation or flagellum-like structure seen by him, or whether it may be simply a slip of the engraver's hand? As regards this production, which, for the present, as Mr. Archer thought, ought to be called *Aporea ambigua* (Bail.), he had nothing to add to what he had mentioned in the minutes referred to, save that the flagella seemed sometimes apparently to emanate from the summits of the branches in tufts or pencils of a few together, and sometimes, though by no means always, a somewhat definitely but not sharply-bounded consolidation of the granular matter terminating the branches, appeared to exist—that is to say, somewhat monad-like, and to some extent resembling the "monads" of *Monas consociata* (Fresenius), but these bodies not at all so clearly marked as in that organism.

Mr. Archer showed a good example of a rhizopod forming, he thought, a second species in the genus he had proposed for the form named *Cystophrys Haeckeliana*. In this the pseudopodia were very fine and long, the central cells reddish, each furnished with a bright dot (nucleus?), very numerous, and sometimes slightly flattened by mutual pressure. The motions of this form are, when freshly taken, often lively and somewhat rapid for a rhizopod; and it is further sometimes addicted to the pastime of tearing itself into two, each half throwing out pseudopodia, and setting up in the world on its own account. This form he had drawn attention to very briefly some time ago, but he thought it justifiable to exhibit so good a specimen, and he hoped to be able to publish a figure he had made. (This appears in the last number of this Journal (vol. ix, N.S., p. 265), under the name of *Cystophrys oculea*.)

Mr. Archer further showed some fine examples of a noble form of Actinophrys, which he had lately met with in one or two places. This comparatively large form usually, though not always, presents

a bright green colour, due to the presence of a dense stratum of somewhat large Chlorophyll granules; the pseudopodia not numerous, but very long and comparatively stout. This could hardly be *Actinophrys viridis* (Ehr.), which is described and figured as minute, and possessing a dense fringe of very fine and slender and short pseudopodia. As regards the present form, however, Mr. Archer would prefer to postpone any further remarks upon it until he had an opportunity again to examine examples of it, suspecting it to present a certain speciality which would deserve a much closer investigation.

Dr. E. Perceval Wright exhibited spicules of a minute sponge, brought up from a depth of 1913 fathoms in lat. 58° 23″ N., long. 48° 50″, by Dr. Wallich. This sponge evidently belonged to the order Vitrea. It was attached by a stalk to a small piece of rock, and the upper or body-portion was about the size of a small pea. A beautiful network of spicules surrounded the whole mass, and underneath this there was a series of the spicules called dichotomo-patento-ternate by Bowerbank, as met with by him in *Dactylocalyx Bowerbankii*. Beyond the record of its occurrence, for which he was indebted to his friend Dr. Wallich, he would not further for the present allude to it.

Mr. Woodworth exhibited various photographs of his own production of microscopic objects, including crystals, which were exceedingly sharp and accurate.

Resolved—That this Club desires to place on record the deep loss which they have sustained by the death of Dr. Maurice H. Collis. Dr. Collis was elected as an ordinary member of our Club some years ago, and his place now vacant will not be easily filled. Devoting himself chiefly to the use of the microscope in connection with the active exercise of his profession, he laboured in this department of research with very considerable success; while his pleasant social qualities and extreme good nature endeared him to the members of our little circle. In placing this record on the minutes, it will not be forgotten that this is the first loss by death of an ordinary member that this Club has experienced since its formation.

27*th May*, 1869.

Mr. Archer brought forward a number of Desmidieæ, taken at Glengariff on the occasion of a recent excursion thither with Dr. Barker and Professor E. P. Wright, some of which deserved a closer examination, and to a few of which he hoped again to revert. Amongst those now shown was a large Staurastrum, which he had very sparingly taken last year in Connemara, but of which he had then tried to find specimens for exhibition at a meeting of the Club, but without success upon that occasion. This was a large triradiate form, in some measure resembling *Staurastrum spinulosum* and *St. vestitum*, but much larger and stouter than either. A special description he would defer. There was also a Cosmarium,

seemingly close to *Cosmarium striolatum* (Näg.); also *Xanthidium Smithii* (Arch.), never before seen by him living, which latter is quite distinct from the so-called sixteen-horned variety of *X. octocorne*.

Amongst the Desmids which turned up from Glengariff were Dr. Barker's *Penium spirostriolatum* and the two Docidia shown by him at the Club Meeting in October, 1868. These occurred in considerable numbers. But Mr. Archer referred to one now—the narrow, straight-sided, tapering form—to say, in allusion to his remarks at the meeting of 15th Oct., 1868 (p. 195), that having seen absolutely fresh specimens he would still feel uncertain as to the arrangement of the endochrome justifying its assuming a place in the genus Pleurotænium (Näg.); the endochrome seemed to form a longitudinal mass in occasional contact with the walls, but not parietal bands.—Mr. Archer likewise showed the zygospores of the 16-spined so-called variety of *Xanthidium octocorne*, which, like many of the more or less nearly allied forms, is orbicular, and beset with not very numerous but long acute subulate spines—in fact, they are fewer and longer than in any of the zygospores most resembling it. —He also showed *Micrasterias Crux-Melitensis* and *M. fimbriata* both in one gathering side by side, from near Tinnehely, Co. Wicklow. This is the first time the former had been found in the east of Ireland; they are both certainly rare in this country, and neither had turned up in the lately made gatherings from Killarney and Glengariff.

Mr. Archer further exhibited the conjugated state of a Penium, possibly new, distinguished by the fact that *two* zygospores resulted from the conjugation of each pair of parent cells. These zygospores were quadrate (cubical in form), thick-walled, large, and densely green. The Penium itself he was unable to identify with any he could find described, but was greatly inclined to think it might be perhaps identical with *Penium rufescens* (Cleve); but if not truly that form, it would seem to be new. It is medium-sized, stout, straight-sided, broadly-rounded at ends. It would, however, be difficult to obtain authentic specimens of Cleve's form, nor indeed is its conjugated state described by him. But the formation of double or twin zygospores is remarkable; this takes place in no other Penium yet observed, and has a parallel in that respect only in *Closterium lineatum*, *C. Ehrenbergii*, and in *Spirotænia condensata*. The almost cubical zygospores are likewise peculiar. As in other cases of double or twin zygospores, they are each, of course, formed from the union of one half the contents of one of the conjugating cells with the opposite half of the contents of the other conjugating-cell. The empty, quite smooth, and hyaline cell-walls of the parent-cells become posed, and remain attached for some time, in a somewhat cruciform manner, each of the *opposite* halves of the conjugating cells now, however, mutually falling more into a line with one another than with the corresponding half of the original parent-cell—that is to say, calling for the moment the opposite ends of each parent-cell the north and south poles, the two

north halves run in one line and the two south halves in another, during the conjugative act.

Dr. Barker brought forward a new Staurastrum, which he had discovered at Glengariff, Co. Cork, when in company with Mr. Archer and Dr. Wright last May. At first sight it looked somewhat like *Staurastrum gracile* undergoing subdivision; it is smaller in arms, not so long or fine proportionately. Although a true Staurastrum, it does not fulfil one of its definitions, each segment of the frond being somewhat longer than broad. The segments are T-shaped, longer than broad, ends crowned with a wreath of fine spines or granules; arms horizontal, each nearly half the length of the segment, and terminated by three or four minute spines; base of each segment inflated spherically, and marked with three or four rows of small spines. Frond deeply constricted in middle; end view triradiate, tapering into elongate, straight, horizontal processes; rough, especially at the most concave parts, between arms, with minute spines. Length, about $\frac{1}{275}$th; breadth, $\frac{1}{400}$th of an inch. He would name this species *Staurastrum elongatum*, in allusion to the great proportional length of this form in comparison to its expanse.

Dr. Macalister showed *Acarus bicaudatus* taken from the ostrich.

Rev. Eugene O'Meara showed *Pleurostigma strigilis* from a lake in Co. Wexford. This appears to be an exceedingly rare form in Ireland, being the second specimen he had as yet found.

Mr. Archer drew attention (though unable to throw any light upon the specimen) to a state of a minute Coleochæte, long regarded and referred to by him as Pringsheim's "seventh species;" that peculiarity, now drawn attention to, seemed to indicate a developmental stage. Pringsheim, in his fine memoir on this genus ('Jahrbücher für wissensch. Botanik,' Bd. ii, page 36; also de Brébisson, 'Ann. des Sciences naturelles,' 3 ser., tome i, pl. ii, fig. 6), describes six species, merely remarking at the end that he knows a seventh, which he believes to be a form mistaken by de Brébisson for an early condition of *Coleochæte scutata*. This "seventh species" appears to be unique in being unicellular, each somewhat pear-shaped cell repeating itself by division, all the cells being finally free, and seemingly equivalent, each bearing one, or sometimes more, of the curious bristles characteristic of the genus. Empty cell-walls are frequently found, but Mr. Archer has never before seen what (sometimes at least) becomes of the contents, imagining that they become removed as zoospores, which indeed may likely be often the case. In the present examples, however, the contents of many of the cells, after emergence through a slit or opening in the parent cell-wall, seemed to have become massed into an elliptic, compressed, spore-like body, enveloped by a sharply-bounded hyaline mucous covering. When the narrow view of this elliptic, fruit-like body is towards the observer, at each end can be seen a minute, somewhat wedge-shaped, or funnel-shaped opening in the mucous covering reaching to the cell-wall. Might this possibly indicate the position of an aperture for the admission of

spermatozoids? Thus the oogonium would be external to the plant, and a structure independent therefrom. But there was no evident place of origin for spermatozoids, unless, indeed, *some* of the empty vegetative cells around might have given birth to them. It is a pity that Pringsheim has not as yet completed the subject by giving the history of this "seventh" species; we should then be in a position to see the true bearing of the present very crude observation; but incomplete as it is, Mr. Archer ventured to think it worth while to call attention to the specimens now shown, never having before seen this condition in this plant.

24th June, 1869.

Rev. E. O'Meara exhibited examples of *Trinacria excavata* from Jutland, of Professor Heiberg's own collection, kindly forwarded by Mr. G. M. Browne. Mr. O'Meara desired, likewise, to record *Toxonidea Gregoriana* and *Cocconeis excentrica* in the same gathering from the coast of Donegal; he also showed *Trinacria regina* and *Soleum exculptum*.

Professor E. Perceval Wright exhibited a new parasitic crustacean, of which he will prepare a detailed account.

Mr. Archer exhibited an example of the zygospore, same as shown by him last year of a Cosmarium, which he thought may often be confounded with *Cosmarium margaritiferum*, but seemingly not named, and very distinct therefrom—distinct, indeed, in its zygospore from any other form whatever. This is large and covered, not with any kind of spines or processes, but with a few large hemispherical hyaline tubercles, not unlike the "bull's eyes" in glass.

Mr. Crowe showed *Closterium linea* (Perty) conjugated in considerable numbers. Its zygospore, at first sub-cruciate, ultimately becomes elliptic, lying longitudinally and freely within the space formed by the union of the parent pair of conjugating cells.

Mr. Archer drew attention to some examples of an organism he had now several times noticed, and which, though not at all at first sight a striking-looking thing, was seemingly not a little puzzling. This ordinarily presents the appearance of a spherical, sharply-bounded, and thinly-walled cell, containing green contents, averaging say $\frac{1}{500}''$ in diameter. It might, perhaps, call to mind a small specimen of *Eremosphæra viridis*—that is, when a cell of that organism exceptionally gives origin to four in place of two daughter-cells. But somewhat like as this may be, there could be no doubt at all that it was not a condition of that organism, yet, perhaps, one might *à priori* regard it as another "species" of Eremosphæra. It could, however, hardly be even so. These cells, as has been mentioned, are ordinarily spherical, but they sometimes present themselves of an elongate figure, broadly elliptic, or fusiform. Some of the green contents appear to be distributed in a scattered manner within the cavity of the cell, whilst ordinarily a number of green granules are disposed in a parietal stratum within the investing cell-

wall, so evenly sometimes that a reticulated effect is presented by the interspaces. But the puzzling and remarkable point was that, immersed in the centre of nearly every one of these so hermetically-closed cells, there presented itself some kind of foreign body, generally resembling a young and small Pandorina, or some such mulberry-shaped cluster of cells, but other things were present in some —sometimes a minute diatom, sometimes one or two joints of *Didymoprium Borreri*, sometimes what appeared to represent a fragment of some nostochaceous filament. These in densely filled cells are, of course, sometimes hard to be made out, requiring strong light and careful focussing. If any of these bodies were more than usually long, or exceeded materially the ordinary diameter of the containing cell, this latter became more or less elongate and distorted, and in such usually the foreign body was more readily perceived. It becomes a query what this organism can be? The green colouring granules are, to all appearance, chlorophyll. It is, perhaps, *somewhat like* a quiescent or rigid and thicker walled state of *Monas grandis* (Ehr.), but it is more probable to be some quiescent state of some rhizopodous creature, notwithstanding its green and very protococcoid appearance. None of the cells ever showed any appearance of self-division. Sometimes similar looking cells are mingled with these, probably a further stage, in which an inner wall appears to be formed, which latter is much thickened, and presents an undulate outline, the extremities or apices of the prominences being in contact with the much thinner spherical outer wall, the contents acquiring a lightish brown or somewhat orange colour, enclosing a large conspicuous, excentric, red (nuclear?) granule. Though Mr. Archer strongly suspected that this was an advanced state of the former, he could not yet be certain. He had several times lately met with this production in our moor pools in various parts, no doubt one and the same thing, but the present examples were probably the most striking he had encountered as regards the foreign bodies enclosed within the thin-walled cells; and he ventured to think, enigmatical as it was, but yet by no means attractive as a "popular" display, that this production deserved the Club's attention.

Dr. Battersby showed Beck's new parabolic side-reflector for opaque objects.

Brighton and Sussex Natural History Society.

August 12.—The President, Mr. Glaisyer, in the chair.—On certain facts in the life History of Moths and Butterflies, by Mr. T. W. Wonfor. In rearing Lepidoptera for the purpose of determining the possession of a distinctive scale by the males, several facts, some well known, others opposed to generally received opinions, and others of a novel character, had forced themselves on

his notice. As was well known the Lepidoptera in passing from the egg to the mature state underwent the several changes of *larva*, *pupa*, and *image*. In two, and in some cases in only one, of these did the insect partake of food. For, while all were voracious in the larval state, and while many possessed a proboscis of great length, other species did not possess any suctorial apparatus, and therefore could not take food. The parent, as a rule, laid the eggs on or near the food substance of the larvæ, the gradual development of which, in many transparent eggs, could be watched under the microscope. While these changes were taking place the colour of the egg also changed. As soon as the larva is ready to escape it eats its way out, *very seldom* at the apex or *micropyle*, but generally below and at one side. The eggs of many are very beautiful objects for the microscope. The larvæ of various, and some of peculiar forms and habits, spend their time in eating and changing their skins. In fact, the chief aim of their existence at this stage is storing up vitality to enable them to undergo their further changes; for, when supplied with insufficient food, or alternately starved and fed, the imago stage is either not reached, or a mutilated or deformed insects results. When the time arrives for the change to the pupa state some construct elaborate coccoons, others suspend themselves from twigs, and others burrow, all casting the last larval coat when they become chrysalides. Just before the final change the colour of the chrysalis alters, and through the pupa case the several parts of the future insect can be made out. At last the pupa case bursts, and the *fully* fledged insect emerges, with wings of minute size; these expand as air and fluid are forced through them. The scales at the time of emerging are all of full size. This is an important fact, for some assert that the scales expand together with the wing membrane itself, the air breathed in entering between the laminæ of each scale; others maintain that the scales are small and few in number in newly-developed insects, but larger and more numerous as the insect increases in age. Both these theories are contrary to fact, as may be proved by examining a wing either before or immediately after the insect has escaped from the pupa case, when it will be seen they are all of full size, but packed closely together, laterally and longitudinally. Experiments made with the Puss Moth and Oak Egger Moth, the former to determine in what way the insect dissolved its hard coccoon, in the latter to discover by what means the males were attracted in such numbers and from such long distances, were next described. Several cases of *parthenogenesis*, in which the larva did not reach the third moult, and examples of a second copulation, were mentioned. The females possessed greater vitality than the males, and made *in articulo mortis* efforts to lay eggs, which in some cases were extended for days after death. While such varied colours were seen in Lepidoptera, the scales themselves when viewed by transmitted light were either colourless or of a dull yellowish tint. As regarded a distinctive scale on the males, there was not a doubt that in many families the

males possessed scales of a peculiar type, known as the "battledore" or "tasselled" scale. Further researches might reveal other types. It could very safely be laid down that no female possessed a battledore or tasselled scale, hence, wherever found, they were indicative of sex. Several other points were advanced, and the life history of different moths and butterflies described, and the paper illustrated by a collection of insects in their several stages, and by microscopic preparations.

It was resolved that a letter of invitation from the Society to the British Association, requesting the honour of a visit to Brighton, be forwarded through Mr. Mayall, who had consented to represent the Society at Exeter.

September 9th.—The Annual Meeting, at which the Committee's Report for the last year was presented, and the officers for the ensuing year elected: President—Mr. T. H. Hennah; Committee—Messrs. Sawyer, Noakes, Dennant, R. Glaisyer, and the Revs. J. H. Cross and J. Image; Treasurer—Mr. T. B. Horne; Hon. Secs.—Messrs. T. W. Wonfor and J. Colbatch; Hon. Librarian—Mr. Gwatkin. After which the ordinary meeting was held—a microscopical one—at which Mr. Hennah exhibited a living beetle, showing structure of mouth, and *Marchantia polymorphia* in fruit, and elaters of same.

Mr. Gwatkin exhibited skin of toad, fossil wood from Great Desert, lung of boa constrictor, and large intestine of ostrich. Dr. Hallifax, section of lady-bird, showing optic and ventral ganglia; ditto, of bee, showing tongue and suctorial apparatus; ditto, of common fly, showing proboscis, and eggs of parasites of Bohemian pheasant and Mallee bird.

Mr. T. Cooper exhibited sections of yew, &c., embryo oysters, and Polycistina.

Mr. R. Glaisyer exhibited sections of crab-shell, pinna, and mitra shells, and Australian Foraminifera.

Mr. Davidson showed Foraminifera from Nice.

Mr. Wonfor exhibited, with a Reade's prism, *Pleurosigma formosum* and *P. angulatum*, injected preparations of Dr. Thudichum's Trichinous rabbit, and a series of the South American pest *Pulex penetrans*, the chigoe or jigger, kindly lent by Mr. Curties, of Holborn.

Mr. Smith exhibited fructification of Hepaticæ.

Mr. Glaisyer exhibited *Sphagnum squamosum* with porous cells and spiral fibres.

There was also exhibited by Mr. Baker, of London, Wright's and other collecting bottles, lamp chimneys to give white cloud light, Reade's prisms, an erecting eye-piece, and other apparatus.

INDEX TO JOURNAL.

VOL. IX, NEW SERIES.

Acanthocystis Pertyana, 252.
Adulteration of tobacco with starch, 76.
Akazga, on the structure of the stems of, by Dr. Fraser, 179.
Allman, Prof., F.R.S., on a new form of Polyzoa, 57.
America, microscopical societies in, 304.
Annelids in the Gulf of Naples, by E. Claparède, 306.
,, development of, 415.
Archer, Wm., on some fresh-water Rhizopoda, 250, 386.
Auditory organs of molluscs, on the, by M. Lacaze Duthiers, 171.

Baronetsky, on the change of Gonidia into Zoospores, 184.
Beale, Lionel S., M. D., F.R.S., on the minute anatomy of the frog's tongue, 1.
,, ,, on the nervous mechanism of the frog's heart, 152.
Biology, principles of, by Herbert Spencer, 187.
Blood, 83, 173, 309, 411.
,, white corpuscles of, identity with the salivary, pus, and mucous corpuscles, by J. G. Richardson, 245.
,, on a new means of examining under the microscope, &c., by E. Ray Lankester, B.A., 296.
Brady, G. Stewardson, C.M Z.S., &c., description of an entomostracan inhabiting coal mines, 23.
Brighton and Sussex Microscopical Society, 216, 426.
Bristol Microscopical Society, 112.
British Association, 415.
Butterfly scales, characteristic of sex, by T. W. Wonfor, Brighton, 19, 426.

Canthocamptus cryptorum, 23.
Cæciliæ, Dr. Leydig on, 412.
Camera lucida, 92.
Carus, J. V., on Noctiluca miliaris, 89
Cell diagnosis, 79.
Cell, the animal, by Herr Wundt, 179.
Chætogaster diaphanus, 284.
,, limnæi, on the sexual form of, by E. Ray Lankester, 272
Claparède, E., on Annelids, 306.
Cleland, J., M.D., on the epithelium of the cornea of the ox, 44.
Coal mine, description of an entomostracan inhabiting a, by E. Stewardson Brady, C.M.Z.S., 23.
Cobbold, T. Spencer, on a trematode from the Indian elephant, 48.
Coccoliths and coccospheres, by G. C. Wallich, 77.
Collosphæra and Sphærozoum, 147.
Cohnheim's views on the passage of white blood corpuscles, 173.
Cooke, M. C., one thousand objects for the microscope, 80.
Cornea, on the epithelium of the cornea of the ox, by John Cleland, M.D., 44.
Cornea, nerves of, by H. Petermöller, 311.
Corpuscles, white, of the blood, identity with the salivary pus and mucous corpuscles, by J. G. Richardson, M.D., 245.
Cutler, Prof. S. P., how to study the structure of teeth, 175.

Cysticercus lumbriculi, by Dr. Fritz Ratzel, 315.
Cystophrys Haeckeliana, 259.

Death, microscopic cause of, 161.
Desmidiaceæ, notes on a point in the habits of, by A. M. Edwards, 64.
Diagnosis, microscopic, 91.
Diaphoropodon mobile, 394.
Diatomaceæ, notes on a point in the habits of, by Arthur Mead Edwards, 64.
,, from dredgings, by Rev. E. O'Meara, 150.
,, on several rare and new species of fresh-water, discovered in Northumberland, by Arthur Scott Donkin, M.D., &c. 287.
Draparnaldia cruciata, Dr. Hicks on, 383.
Dublin Microscopical Club, 94, 194, 320, 420.
Donkin, Arthur Scott, M.D., on several new and rare species of Fresh-water Diatomaceæ, 287.
,, on certain new diatomaceæ, 397, 402.
Duthiers, M. Lacaze, on the auditory organs of molluscs, 171.

Edwards, A. M., notes on a point in the habits of Diatomaceæ and Desmidiaceæ, 64.
Embletonia, discovery of, in Victoria Docks, 193.
Embryology, 87, 183, 415.
Entomostracan, description of an, inhabiting a coal mine, by G. Stewardson Brady, C.M.Z.S., 23.
Epithelium, on the, of the cornea of the ox, by J. Cleland, M.D., 44.

Frog's tongue, minute anatomy of the papillæ of, by Lionel S. Beale, M.D., F.R.S. &c. &c., 1.
,, heart, nervous mechanism of, by Lionel S. Beale, M.B., F.R.S., 152.

Focke, G. W., on naked Fresh-water Radiolaria, 67.
Famintzen, A., on the change of Gonidia into Zoospores, 184.
Fraser, Dr., on the structure of Akanga stems, 179.

Glands, 86, 178, 411.
Goodsir, John, F.R.S., Memoirs of, 163.
Gonidia in lichens, change of, into Zoospores, 184.
Gordius, on the anatomy of, by Dr. H. Grenacher, 88.
Grenacher, Dr. H., on the anatomy of Gordius, 88.
Gromia socialis, 390.
Gulliver, George, on Raphides, Sphæraphides, and crystal prisms, 232.
Gulf stream, Fauna of, at great depths, 158.

Häckel, Ernst, monograph of Monera, 27, 113, 219, 327.
Heterophrys Fockii, 267.
,, myriopoda, 267.
Histology, 82, 171, 309, 411.

Lamp shade, new, "white cloud," 156.
Lankester, E. Ray, on the sexual form of Chætogaster limnæi, 272.
,, on a new means of examining blood under the microscope, and on a natural standard for registering absorption spectra, 296.
Leucocytes, on the spontaneous formation of, by M. Onimus, 189.
Lenses, Nachet's and other immersion, 79.
Lichens, micro-lichens parasitic on other, by W. Lauder Lindsay, M.D., &c. 49, 135, 342.
Lichen Zoospores, 162.
Lichens, on the change of Gonidea into Zoospores in, by MM. A. Famintzen and J. Baronetsky, 184.
Lindsay, Lauder, on micro-lichens parasitic on other Lichens, 49, 135, 342.
Lubbock, Sir John, Bart., notes on the Thysanura, 285.
Lymph, 83.

Macdonald, J. D., on Thalassicolidæ, 147.
Manchester Literary and Philosophical Society, 104, 212.
,, Circulating Microscopical Cabinet, 216.

Mayall, John, jun., on immersion objectives and test-objects, 242.
Melosira Wrightii, 151.
Micro-lichens parasitic on other lichens, by Lauder Lindsay, M.D., &c., 49, 135.
Microscope, one thousand objects for, by M. C. Cooke, 80.
Microscopy in Russia, 159.
Microscopical Society, Royal, 98, 155, 202, 324.
Microzoology and microphytology, 87.
,, 186, 313, 415.
Mineralogy, application of the microscope to, by Mr. H. C. Sorby, 182.
Molecular and microscopical science, review of, 403.
Monera, monograph of, by Ernst Häckel, 27, 113, 219, 327.
Mosley Street Natural History Society, 213.
Muller, C. J., on Vaginicola valvata, 25.
Muscles, 83, 173, 312, 411.
Myxastrum radians, 123.
Myxodictyum sociale, 131.

Nachet's and other immersion lenses, 79.
Navicula nobilis, 288.
,, Coquedensis, 293.
,, vernalis, 293.
,, Cymbula, 294.
,, stauroptera, 295.
,, firma, 295.
Nerve, 82, 171, 309, 411.
Nobert's lines, 401.
Noctiluca miliaris, by J. Victor Carus, 89.
Nylander, Dr. W., on the germination of the varicellaria germinata, 183.

Objectives and test-objects, immersion, by John Mayall, jun., F.R.M.S., 242.
O'Meara, Eugene, Rev., on diatomaceæ from dredgings off the Aran Islands, 150.
Onimus, Mons., on the spontaneous formation of leucocytes, 189.
Ovary, on the dimorphism of the, in Tubifex, by Dr. Fritz Ratzel, 314.

Palu, 79.
Petermöller, H., on the nerves of the cornea, 311.
Pinnularia marginata, 151.
,, scutellum, 151.
Plagiogramma costatum, 150.
Polyzoa, rhabdopleura, a new form of, by Prof. Allman, 59.
Pompholyxophrys puniceae, 386.
Protamœba primitiva, 219.
Protoplasm, Huxley and Beale on, 300.
Protomyxa aurantiaca, 34.
Protozoa, by G. C. Wallich, 190.

Quekett Microscopical Club, 102, 211.

Radiolaria, on naked freshwater, by G. W. Focke, Bremen, 67.
Raphides, sphæraphides and crystal prisms, by George Gulliver, F.R.S., 232.
Raphidiophrys viridis, 255.
Ratzel, Fritz, Dr., on the dimorphism of the ovary in Tubifex, 314.
,, on Cysticercus Lumbriculi, 315.
Reviews, 80, 163, 306, 403.
Rhabdopleura, a new form of Polyzoa, by Prof. Allman, F.R.S., 57.
Rhizopoda on some freshwater, by Wm. Archer, 250.
Richardson, J. G., M.D., on the identity of the white blood-corpuscles with the salivary pus and mucous corpuscles, 245.

Shell, 313.
Snow crystals, 158.
Sorby, H. C., F.R.S., on the colouring matters of blue decayed wood, 43.
,, application of the microscope to mineralogy, 182.
,, technical applications of the spectrum microscope, 358.
Sphærozoum and collosphæra, 147.
Spencer, Herbert, on Heterogenesis, 187.
Spectra, on a natural standard for registering absorption, by E. Ray Lankester, 296.
Stage, Beck's, concentric rotating, 159.

Stokes on Dr. Donkin's paper, 401.
Surirella Capronei, 162.
" biserrata, 288.
" Barrowcliffia, 291.
" subalpina, 292.
" tenera, 293.

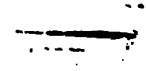
Technical applications of the spectrum microscope, H. C. Sorby on, 358.
Teeth, how to study the structure of, by Prof. S. P. Cutler, 175.
Test-objects and objectives, immersion, by John Mayall, jun., F.R.M.S., 242.
Test-object, new, 401.
Thalassicolidæ, structure and relationship of simple and compound, by J. D. MacDonald, M.D., F.R.S., &c., 147.
" by G. C. Wallich, 190.
Tobacco, adulteration of with starch, 76.
Tongue, minute anatomy of the papillæ of the frog's, by Lionel S. Beale, M.D., F.R.S., &c., 1.
Thysanura, notes on the, by Sir J. Lubbock, F.R.S., 285.
Trematode, from the Indian elephant, by T. Spencer Cobbold, M.D., F.R.S., 48.

Vaginicola valvata, by C. J. Muller, 25.
Varicellaria, germination of the spores of, by Dr. W. Nylander, 183.

Wallich, G. C., on coccoliths and coccospheres, 77.
" on Protozoa, 190.
" on Thalassicollidæ, 190.
Wonfor, T. W., Brighton, on certain butterfly scales characteristic of sex, 19, 426.
Wood, on the colouring matter of blue decayed by H. C. Sorby, F.R.S., 43.
Woodward's, Dr., paper, 158.
Wundt, Herr, on the animal cell, 179.

Zoological literature, Van Voorst, 80.
Zoospores, lichen, 162.
" on the change of gonidia into, 184.

PRINTED BY J. E. ADLARD, BARTHOLOMEW CLOSE.



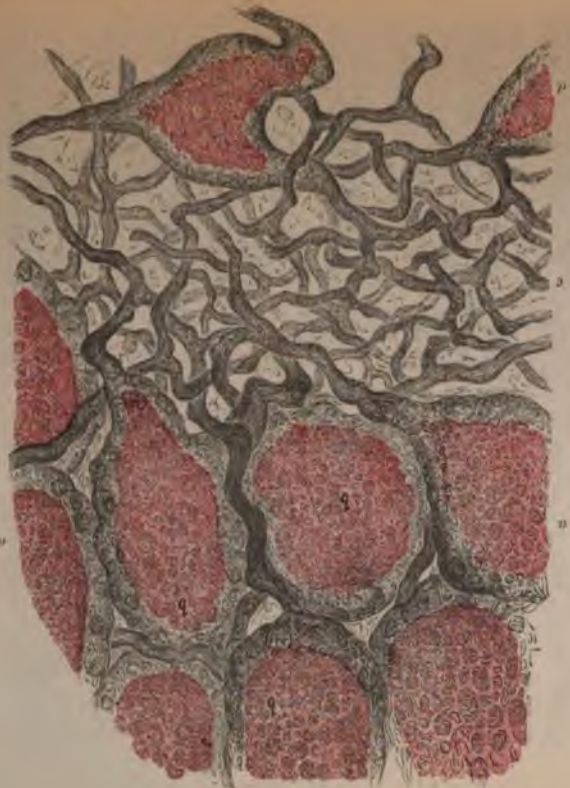


FIG. 2.

FIG. 1.

DESCRIPTION OF PLATE I,

Illustrating Dr. Beale's Paper on the Minute Anatomy of the Papillæ of the Frog's Tongue.

Fig.

1.—Fungiform and simple papillæ of tongue of the Hyla. *a*. Epithelium-like mass at summit of papilla. *b*. Ciliated epithelium at the sides of the papilla. *c*. Ciliated epithelium, covering simple papillæ. *d d*. Summits of two simple papillæ, with nuclei connected with the nerves projecting from them. *e*. Fine nerve-fibres with their nuclei in the connective tissue. *f*. Fine nerve-fibres, which may be traced to the nerve-trunk, *g*. *h*. Muscular fibres, freely branching, the tendinous prolongations of the finest subdivisions being inserted into the connective tissue at the summit of the papilla. *i*. Capillary, with its nerve-fibres. × 215.

2.—Small portion of the plexus of nerve-fibres at the summit of the papilla, showing the connection of the nerve-fibres with the cells. × 2800. *a*. Epithelium-like cells upon the summit, as in figs. 1, 3, and 4. *d*. Triangular cells connected with delicate nerve-fibres. *b*. Germinal matter of epithelium-like cells on summit. The plexus, *c*, corresponds to that marked *b* in fig. 3.

DESCRIPTION OF PLATE II,

Illustrating Dr. Beale's Paper on the Minute Anatomy of the Papillæ of the Frog's Tongue.

Fig.

3.—Portion of the central stem of nerve-fibres, breaking up to form the nerve plexus at the top of papilla. *a*. Epithelium-like cells near the summit of the papilla. *b*. Intricate interlacement of finest nerve-fibres immediately below, highly magnified at *c*, fig. 2. *c*. Expansion of nerve-fibres in the form of a network on the top of the papilla. × 1700.

4.—Diagram to show the supposed arrangement of the nerves, and their connection with the cells on the summit of the papilla.

5.—A portion of one of the triangular cells or nuclei connected with the fine nerve-fibres, forming the plexus at the top of the papilla, as seen after the removal of the epithelium-like mass from the summit. The fine fibres upon the surface are those which pass to the epithelium-like mass on the summit. × 6000.

6.—Three cells from the epithelium-like mass upon the summit of the papilla. × 2000.

7.—Free surface of the cells of the epithelium-like mass at the summit of the papilla. × 2000.

8.—Fine nerve-fibres coming off from a trunk, to be distributed to muscles, vessels, and connective tissue, near the base of a papilla, as at *f*, fig. 1. × 1800.

9.—Muscular fibres at the summit of the papilla, showing the relation of the germinal matter to the contractile tissue, and the mode of formation of the latter by the masses of germinal matter. *a*. Germinal matter, or nucleus forming fibrillæ. *b*. Another nucleus, or mass of germinal matter, connected with muscular tissue. *c*. Germinal matter, or nucleus of fine nerve-fibre, distributed to the muscle near the summit of the papilla. *d*. Fine nerve-fibre. × 1800.

Fig. 3.

Fig. 4.

Fig. 6.

Fig. 7.

Fig. 5.

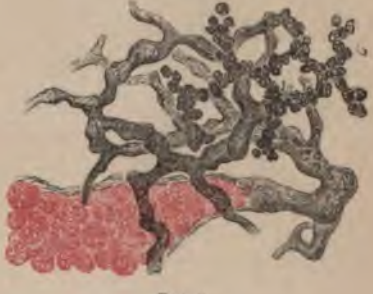


Fig. 8.

Fig. 9.

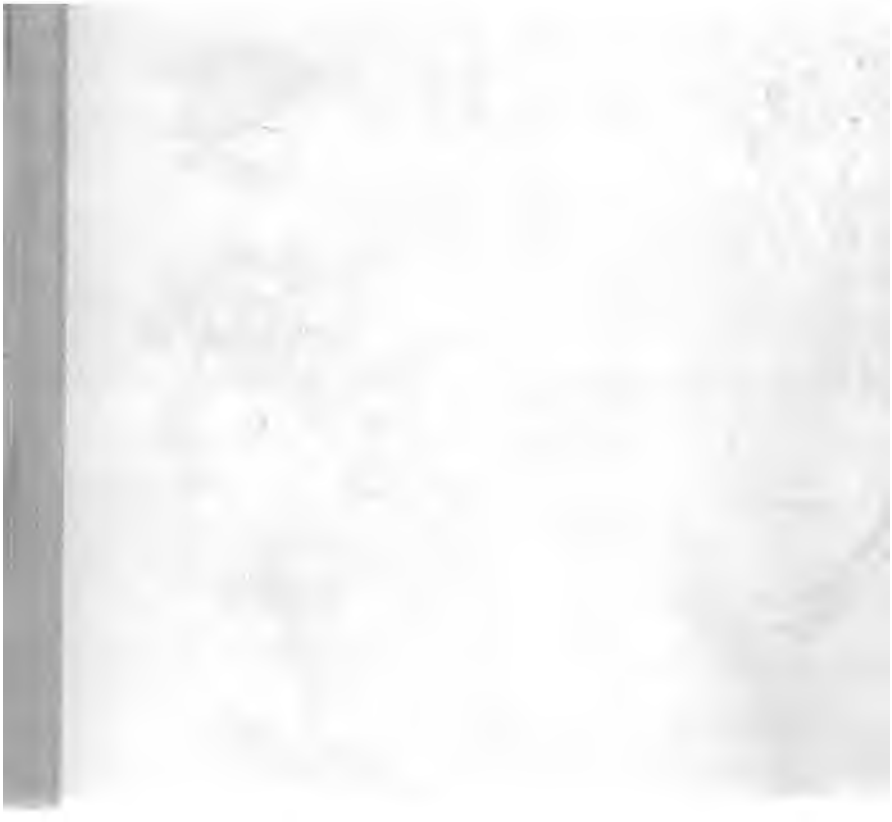


Fig. 10.

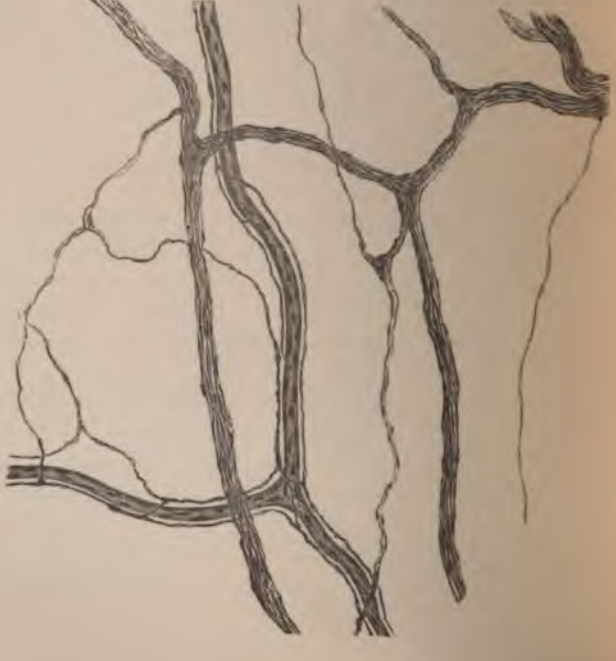
Fig. 11.

Fig. 12.

Fig. 13.

Fig. 14.

Fig. 15.



DESCRIPTION OF PLATE III,

Illustrating Dr. Beale's Paper on the Minute Anatomy of the Papillæ of the Frog's Tongue..

Fig.

10.—Diagram of three papillæ from the frog's tongue, to show the arrangement of the nerve-fibres.

11.—Muscular fibres from tongue, with nerve-fibres ramifying amongst them.

12.—Fine muscular fibre to show a fault. × 1800.

13.—Drawing to show the mode in which the mass of germinal matter 'nucleus' takes part in the formation of the fibrillæ of muscle. The arrow shows the direction in which the nucleus moves. It once occupied the interval between *c* and *d*, but has moved to the position between *b* and *c*.

14.—Drawing to show the plexuses or networks of fine nerve-fibres. The mode of subdivision of the dark-bordered fibres, and the manner in which they enter into the formation of the plexuses, are also well seen. The course of the numerous nerve-currents is indicated by the dotted lines.

15.—From the mylohyoid muscle of the Hyla. Trunks of fine dark-bordered nerve-fibres, with fine fibres coming from them, some of which may be traced to the vessels, while others are distributed to the muscular fibres, which are not represented in the drawing. The arrangement of the nerves supplying the capillary vessel is well seen. × 110.

DESCRIPTION OF PLATE IV,

Illustrating Dr. Beale's Paper on the Minute Anatomy of the Papillæ of the Frog's Tongue.

Fig.

16.—Mode of formation of network or plexus of finest nerve-fibres.

17.—Mode in which a single nerve-fibre is supposed to terminate, according to most authors.

18.—The author's view of the arrangement of the nerve-fibres and formation of the terminal plexus or network of fine nerve-fibres.

19.—Arrangement of terminal pale nucleated nerve-fibres in simple papillæ.

20.—Division of dark-bordered nerve-fibres, with fine fibres ramifying in the sheath. Breast muscle, frog. × 300.

21 & 22.—Diagrams to illustrate the course of the nerve-fibres in a branch, *a*, coming off from a larger trunk, *b b*.

23.—Fine compound nerve-trunk, with a branch coming off at right angles, composed of fibres which pursue opposite courses in the trunk. From the submucous tissue of the palate. Frog. × 700. 1862.

24.—A copy of Hartmann's figure referred to in page 3, showing the nerves in the centre of the papilla, which, according to him, terminate abruptly. The nerves have been much altered by the method of preparation pursued, and the finer branches are invisible.

Fig. 16.

Fig. 17.

Fig. 18.

Fig. 19.

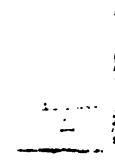
Fig. 20.

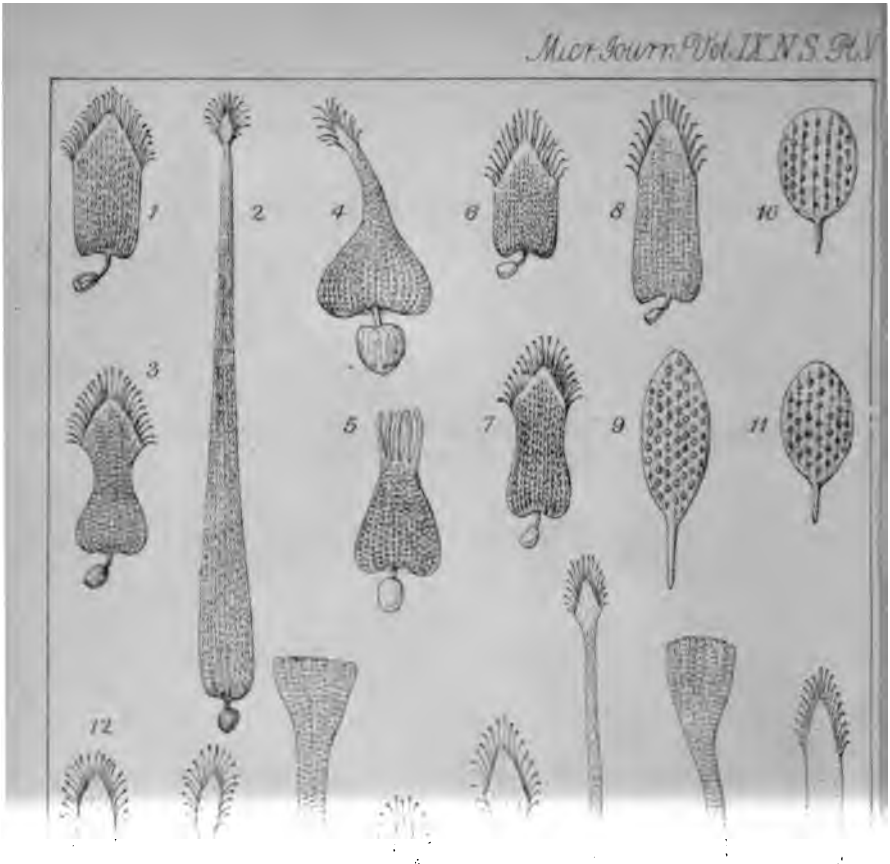
Fig. 21.

Fig. 22.

Fig. 23.

Fig. 24.




1
2
4
6
8
10
3
5
7
9
11
12

DESCRIPTION OF PLATE V,

Illustrating Mr. Wonfor's second paper on "Certain Butterfly Scales characteristic of Sex."

Fig.

1.—*Aporia Cratægi.* (Black-veined white.)
2.—*Pieris Larima.*
3.— „ *Pigea.*
4.— „ *Epicharis.*
5.— „ *Agathina.*
6.—*Anthocharis Danai.*
7.— „ *Antevippe.*
8.— „ *Evippe.*
9.—*Polyommatus Dorylas.*
10.— „ *Argus.*
11.— „ *Œgon.*
12.—*Argynnis Aglaia.* (Dark green fritillary.)
13.— „ *Paphia.* (Silver-washed fritillary.)
14.— „ „ (Hair-like and clubbed scale from fig. 13.)
15.— „ *Adippe.* (High brown fritillary.)
16.— „ *?* (A South American fritillary.)
17.— „ *?* (An African fritillary.)
18.— „ *?* (Hair-like scale from fig. 17.)
19.— „ *?* (An African fritillary.)
20.—Scales overlapping, as seen on unexpanded wing of newly-escaped butterfly.
21.—Scales as seen on fully expanded wing.
22.—Full size of fore wing of large white when escaping from pupa case.
23.—Size of fore wing of same butterfly fully developed.

(Figs. 1—19 magnified 240 diameters.)

DESCRIPTION OF PLATE VI,

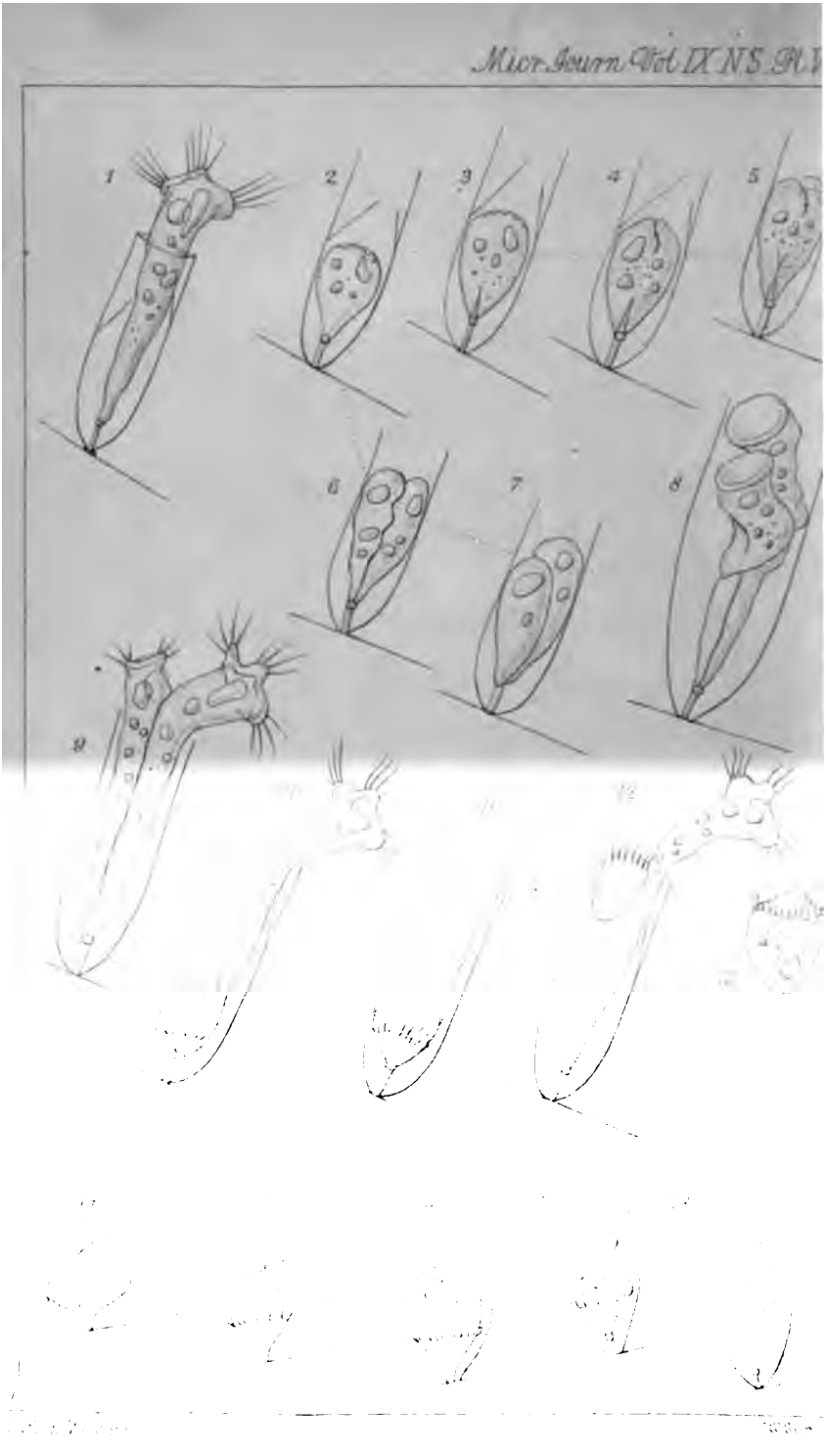
Illustrating Mr. Brady's paper on an Entomostracan inhabiting a Coal Mine.

Fig.

1.—*Canthocamptus cryptorum*, female. × 120.
2.—Superior antenna of the same.
3.— ,, ,, male.
4.—Inferior antenna.
5.—Lower-foot-jaw.
6.—Foot of first pair.
7.— ,, second pair.
8.— ,, fourth pair.
9.— ,, fifth pair.
10.—Last abdominal segments.

Figs. 2 to 10 × 400.

2
1
3
4
5
6
8
7
9
10


1
2
3
4
5
6
7
8
9

DESCRIPTION OF PLATE VII,

Illustrating Mr. Muller's Paper on Vaginicola.

Fig.

1.—*Vaginicola valvata.*

2—8.—Various stages of division.

9.—The divided animalcules.

10—12.—Progress of change in a single animalcule.

13.—The free animalcule after escape from the case.

14—18.—Progress after attachment to a filament of Conferva, until development into fig. 1.

DESCRIPTION OF PLATE VIII,

Illustrating Professor Allman's Paper on Rhabdopleura.

Fig.

1.—A portion of the cœnœcium, with the contained polypides, of *Rhabdopleura Normani*, very much enlarged.
a, *a*, free annulated terminations of the tubes. *b*, *b*, polypides. *b'*, *b'*, shield-like process of the lophophore. *c*, *c*, funiculus. *d*, *d*, chitinous rod (blastophore). *e*, *e*, statoblasts. *f*, *f*, budding polypides.

2.—Polypide withdrawn from the tube, and still further enlarged.
a, lophophore, with the tentacles. *b*, shield. *c*, stomach of polypide. *d*, *d*, funiculus, with its enlargements. *d'*, *d'*, great retractor muscle of polypide, accompanying the funiculus. *e*, enlarged termination of the blastophore, to which the funiculus and retractor muscle are attached.

3.—Statoblast.
a, the statoblast. *b*, *b*, the blastophore.

4.—A piece of the adherent portion of the cœnœcium tube, to show the peculiar markings on its surface.

5.—Very early stage of polypide bud.

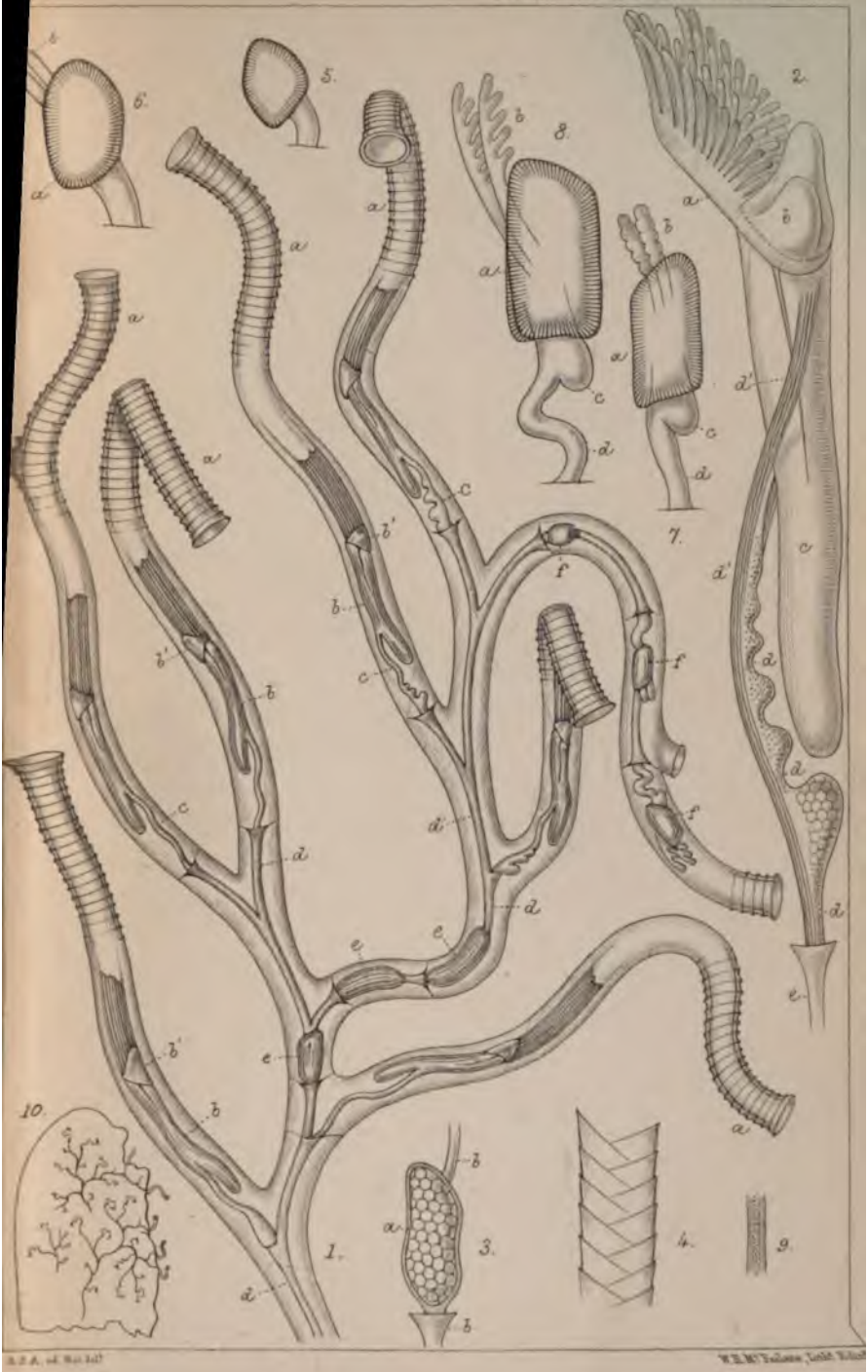
6.—A somewhat more advanced stage.
a, the left of the two fleshy plates between which the body of the developing polypide is included. *b*, the two arms of the young lophophore, protruded from between the two plates, and as yet without any indications of tentacles.

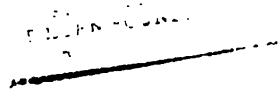
7.—The polypide bud in a still more advanced stage.
a, the lateral plates. *b*, the arms of the lophophore protruded from between them, and now showing the commencing tentacles in the form of tubercles projecting from their sides. *c*, the fundus of the stomach projecting from between the distal edges of the plates. *d*, the funiculus.

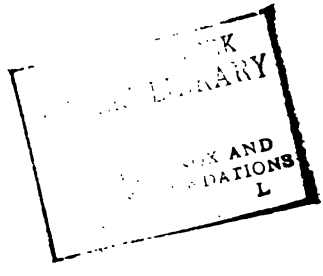
8.—The polypide bud, still more advanced in its development.
a, the lateral plates. *b*, the arms of the lophophore, now carrying short but distinct tentacles. *c*, fundus of stomach. *d*, funiculus.

9.—A piece of the chitinous rod or blastophore taken from a young branch, to show its axile cavity.

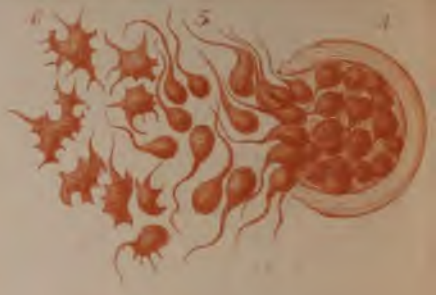
10.—*Rhabdopleura Normani*, natural size. The blastophore, with its attached polypides, is seen creeping over the surface of a fragment of mussel shell; the free terminations of the tubes are seen extending beyond the broken edge of the shell. They are not represented on the rest of the specimen.


1.
2.
3.
4.
5.
6.
7.
8.
9.
10.




K
LIBRARY
K AND
DATIONS
L

1


6
5
4

7

8

11

9

10

12

2

3

DESCRIPTION OF PLATE IX,

Illustrating Ernst Haeckel's Monograph of Monera.

Protomyxa aurantiaca.

Fig.

1.—*Protomyxa aurantiaca* encysted, in the stationary condition; a homogeneous orange-red ball of protoplasm, surrounded by a soft, structureless, gelatinous covering. × 300.

2.—The same, at the commencement of its development. The homogeneous orange-red ball of protoplasm has retracted itself from the inside of the wall of the cyst, has become thickened, and has begun to divide into numerous small globular bodies; between the plasma-ball and the outer covering a little clear fluid has collected. × 300.

3.—The same, further developed. The plasma-ball is entirely divided into numerous small globular bodies of uniform size; these, lying loosely together, again fill up the entire interior of the globular cyst. × 300.

4.—The small globular masses of protoplasm which have resulted from the breaking up of the encysted plasma-ball draw themselves out at one end into a long tail, and issue as "swarm-spores" with a lively motion from the cyst ("sporangium"). × 300.

5.—Ten separate pear-shaped spores, moving briskly about with the aid of their tails, after their exit from the ruptured cyst; the body as well as the tail of the spore is a perfectly naked and homogeneous sarcode mass. × 380.

6.—Seven separate sporules, which, becoming stationary, have retracted their tails, and protruded instead a number of pointed, irregularly formed processes (pseudopods); they creep about with the aid of these with a constant but slow change of form in the manner of an amœba; the homogeneous plasma-body is still without vacuoli. × 380.

7.—Three amœba-like germs (creeping sporules) unite themselves by their anastomosing pseudopods, and finally unite entirely into one single plasma-body (plasmodium); single vacuoli (*v*) are already to be noticed in the plasma. × 220.

PLATE IX (*continued*).

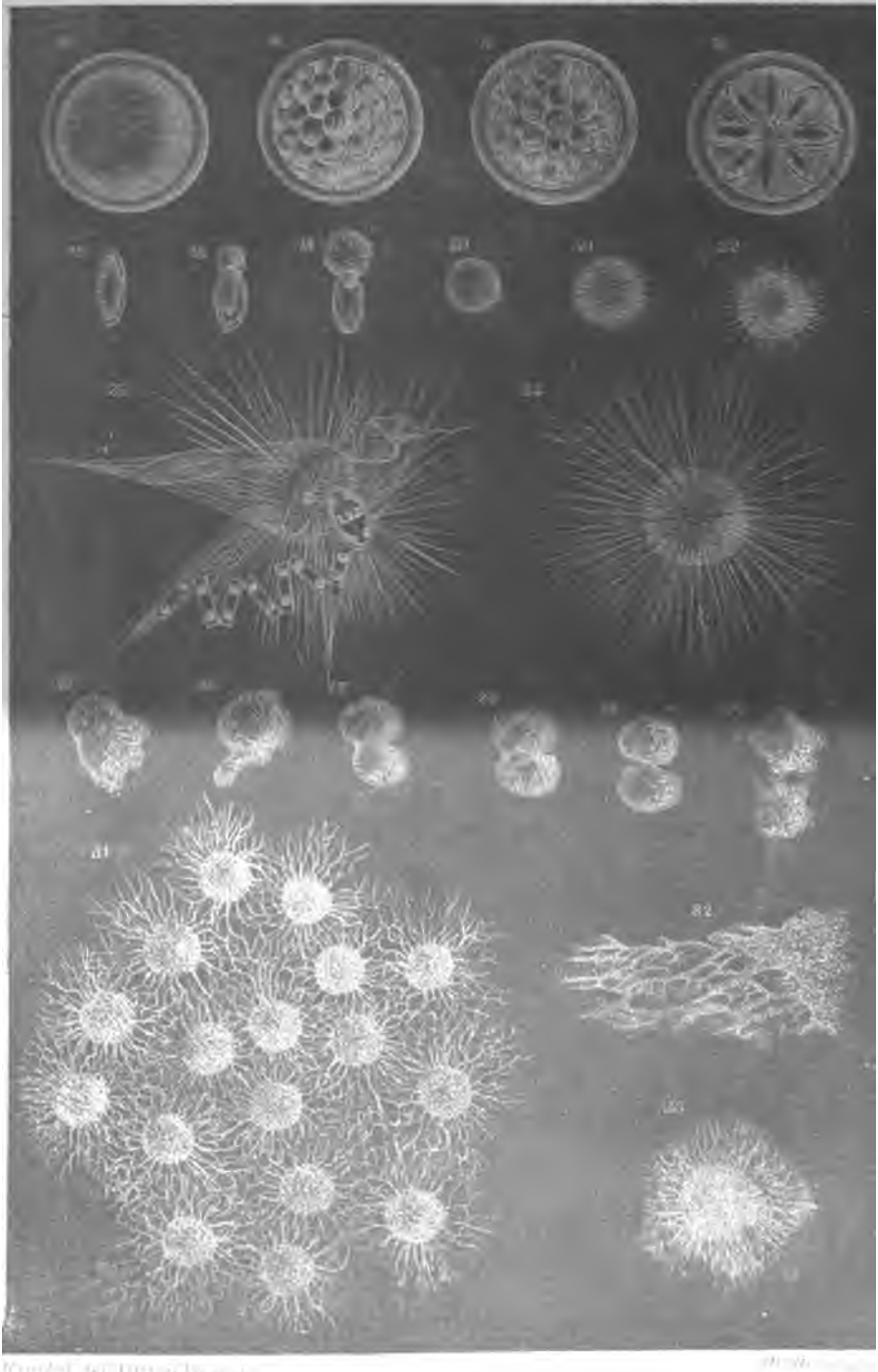
8.—Two amœba-like germs (of those represented in fig. 6) seize a diatome (*Navicula*), each at a different end. × 220.

9.—The same two amœba-germs as in fig. 8, seen somewhat later, in drawing themselves over the *Navicula*, have encountered in the middle, and have here united themselves into one. × 220.

10.—An older *Protomyxa* developed into a plasmodium, either from the simple increase of a single amœba-like germ, or by the union of a larger number of amœbæ. A devoured *Isthmia* and a *Navicula* are visible in the homogeneous parenchyma of the sarcode, also numerous vacuoli (*v*). × 220.

11.—A full-grown *Protomyxa* in the best-fed condition, after a very liberal diet. In the interior of the central protoplasm-body are numerous vacuoli (*v*); above are seen two *Isthmiæ* still entire, with three of the latticed siliceous shells of pelagic *Tintinnoidæ* (two *Dictyocysta elegans* and one *D. mitra*); one shell seems to be just ejected. From the central sarcode-body the very strong, branching, tree-like pseudopods radiate; their peripheral anastomoses show numerous crescent-shaped meshes. Above, several strong pseudopods have seized and surrounded a three-horned *Peridinium*. The formation of vacuoli extends also to the larger pseudopods. × 220.

12.—A full-grown *Protomyxa*, fasting, without food. From the entirely homogeneous sarcode-body radiate a very large quantity of tree-like branching pseudopods, which form only a few anastomoses, and are but scantily supplied with corpuscles. The number of vacuoli in the central protoplasm-body is insignificant. × 140.



DESCRIPTION OF PLATE X,

Illustrating Ernst Haeckel's Monograph of Monera.

Fig. 13—24. *Myxastrum radians.*

Fig.

13.—*Myxastrum radians*, encysted, in the motionless condition; a homogeneous colourless ball of protoplasm, surrounded by a tough, structureless gelatinous covering. × 450.

14.—The same, at the commencement of its development. The homogeneous colourless ball of protoplasm begins to divide by radial cleavage into numerous conical portions, whose points rest towards the centre of the ball, while their rounded bases produce a mulberry-shaped outline towards the surface of the plasma-ball. × 450.

15.—The same, further developed. The cone-shaped divisions of plasma, which resulted from the radial cleavage of the encysted plasma-ball, have assumed a spindle-shape, and each separate one has developed a siliceous covering. The encysted *Myxastrum* now forms a globular sporangium, which encloses numerous spindle-shaped, siliceous spores. × 450.

16.—The same sporangium as in fig. 15. The focus of the microscope is placed so that one can perceive the star-like arrangement of the siliceous spindle-shaped spores. × 450.

17.—The empty siliceous shell of a spore; the protoplasm-body has already slipped out. × 450.

18. A spore whose contents have just begun to glide out from the siliceous shell. × 450.

19.—The same spore as fig. 18, but seen a short time later. There is now only a little sarcode remaining in the siliceous shell. × 458.

20.—The homogeneous sarcode-body of a spore which has entirely left its siliceous shell (fig. 17), and has assumed a globular form. × 450.

21.—The same sarcode-ball as fig. 20, seen some time afterwards. Fine striæ begin to appear everywhere on the surface. × 450.

22.—A somewhat older globular *Myxastrum*, whose radial pseudopods are already longer. × 450.

PLATE X (*continued*).

23.—A full-grown *Myxastrum* during very rich nourishment; indeed, as well fed as possible. The radial pseudopods, which radiate from the central plasma-ball, arrange themselves in tufts over the captured morsels of prey, and draw them into the sarcode-body. In the middle are seen three *Naviculæ;* beneath, a chain of *Bacillaria;* and above and on the right a *Peridinium.* A great quantity of corpuscles are scattered through the protoplasm. × 280.

24.—A full grown *Myxastrum*, fasting, without food. From the whole homogeneous sarcode-body radiate a very large number of stiffened, simple, radial pseudopods, of which only very few ramify or anastomose. The number of corpuscles in the plasma is very inconsiderable. × 280.

Fig. 25—30. *Protamœba primitiva.* × 400.

25.— *Protamœba primitiva*, with several short processes.

26.—The same, with a long process.

27.—The same, at the first commencement of fission.

28.—The same, with the division further advanced.

29.—The same, with the division nearly completed.

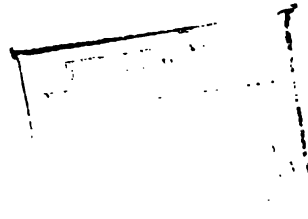
30.—The same, divided into two individuals (A and B).

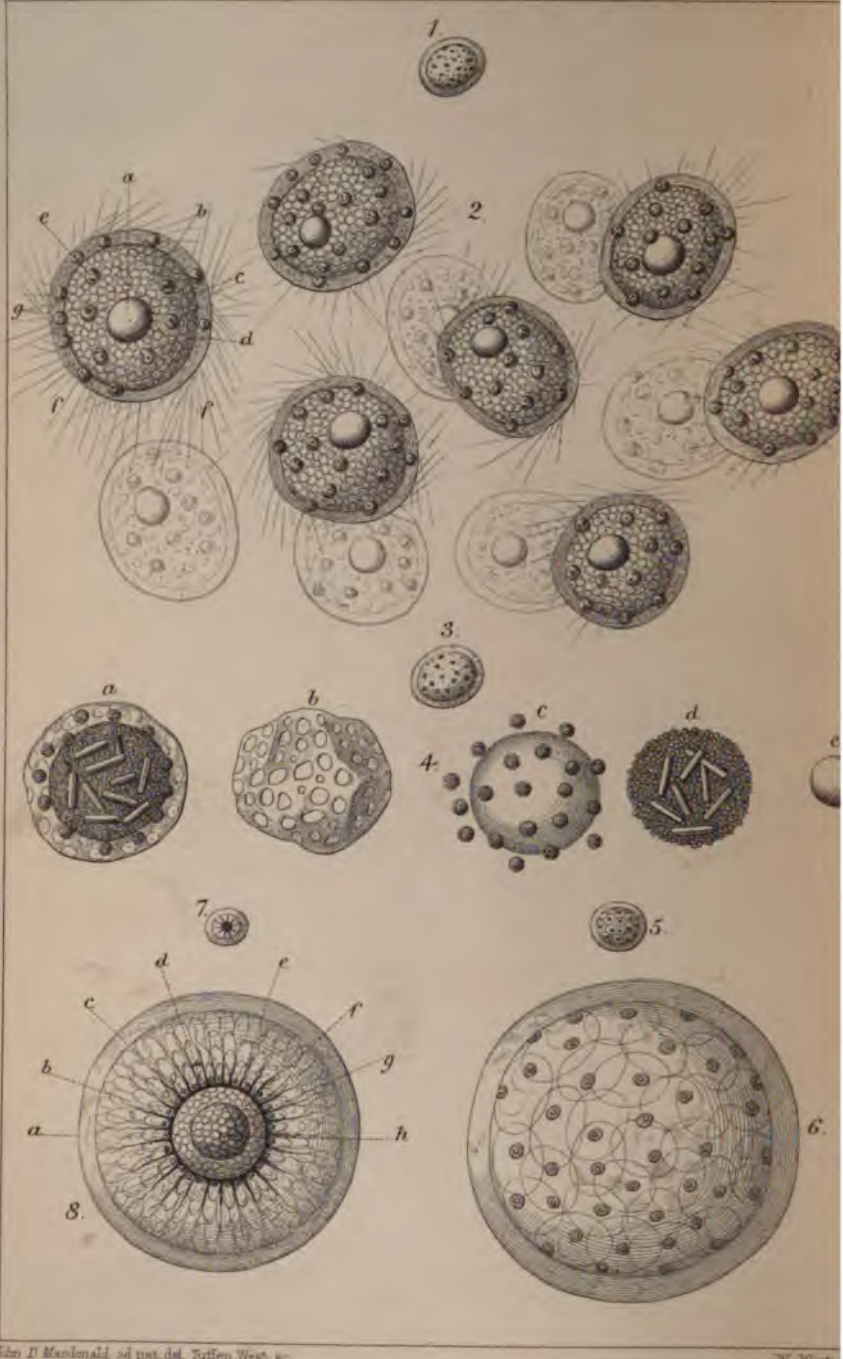
Fig. 31—33. *Myxodictyum sociale.*

31.—*Myxodictyum sociale*, a colony of seventeen actinophrys-like Monera, united by a sarcode-net. × 400.

32.—A single portion of the sarcode-net. × 600.

33.—A single individual which has detached itself from the colony of seventeen Monera. × 400.





John D. Macdonald. ad nat. del. Tuffen West. sc.

W. West.

DESCRIPTION OF PLATE XI,

Illustrating Dr. Macdonald's Paper on the Thalassicollidæ.

Fig.

1.—Globular specimen of *Sphærozoum*, natural size.

2.—Portion of the same, highly magnified, to show the structure of the puncta as described in the text.

3.—Globular specimen of *Collosphæra*, natural size.

4.—Analysis of a single punctum of the same. *a*. Punctum in its entirety. *b*. The fenestrated shell. *c*. The sarco-blasts and cell membrane. *d*. Granular and crystalline contents. *e*. Fatty globule or nucleus.

5.—Example of *Sphærozoum*, like fig. 1, natural size, for comparison with—

6.—An enlarged representation of the same, in which the test, vacuolated matrix and the disposition of the puncta are distinctly seen.

7.—*Thalassicolla nucleata*, natural size.

8.—The same, considerably magnified, showing the test, vacuolated matrix, radiating fibres, sarco-blasts, pigment, proper cell membrane, with rounded granular contents and vesicular nucleus containing minute fatty globules.

DESCRIPTION OF PLATE XII,

Illustrating Rev. E. O'Meara's Paper on Diatomaceous Forms from Arran Islands.

Fig.

1.—*Pleurosigma giganteum*, var. *baccatum*.

2.—*Plagiogramma costatum*. *a*. Front view.

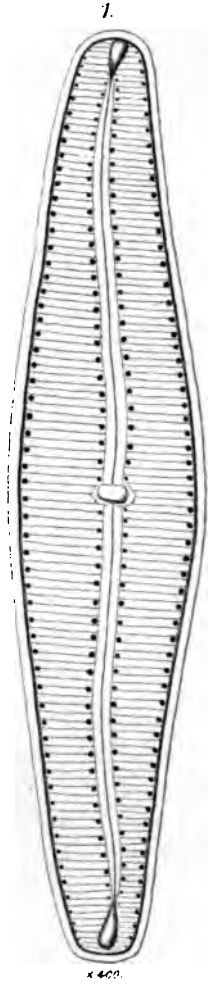
3.—*Melosira Wrightii*. *a*. Side view.

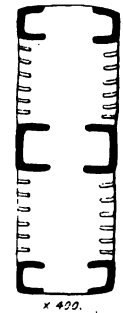
4.—*Pinnularia marginata*.

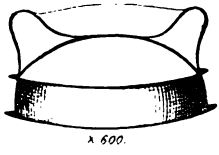
5.—*Pinnularia scutellum*.

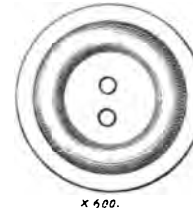
6.—*Amphiprora costata*

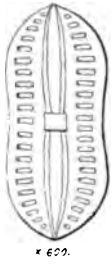
2
x 400

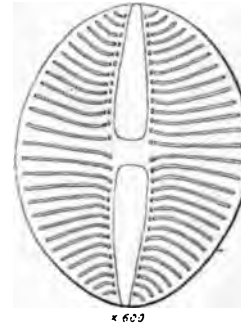

1.
x 400.

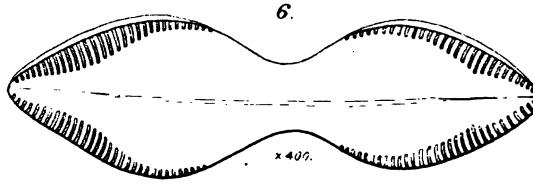

2a.
x 400.


3.
x 600.


3a.
x 600.


4.
x 600.


5.
x 600


6.
x 400.

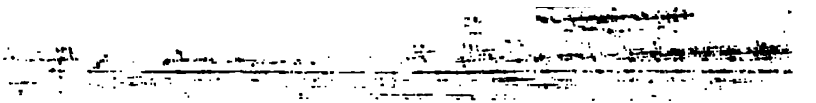
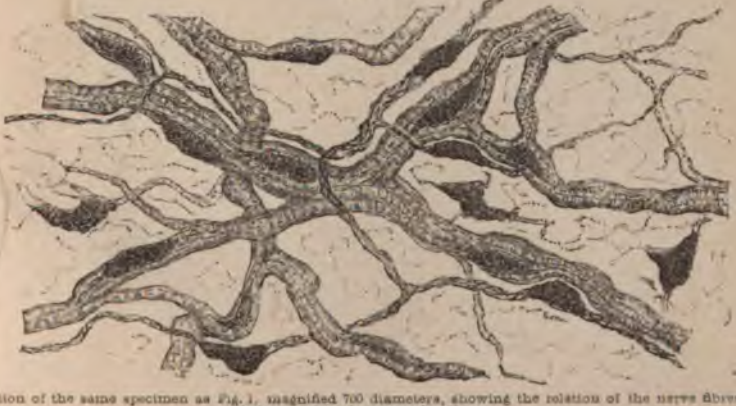


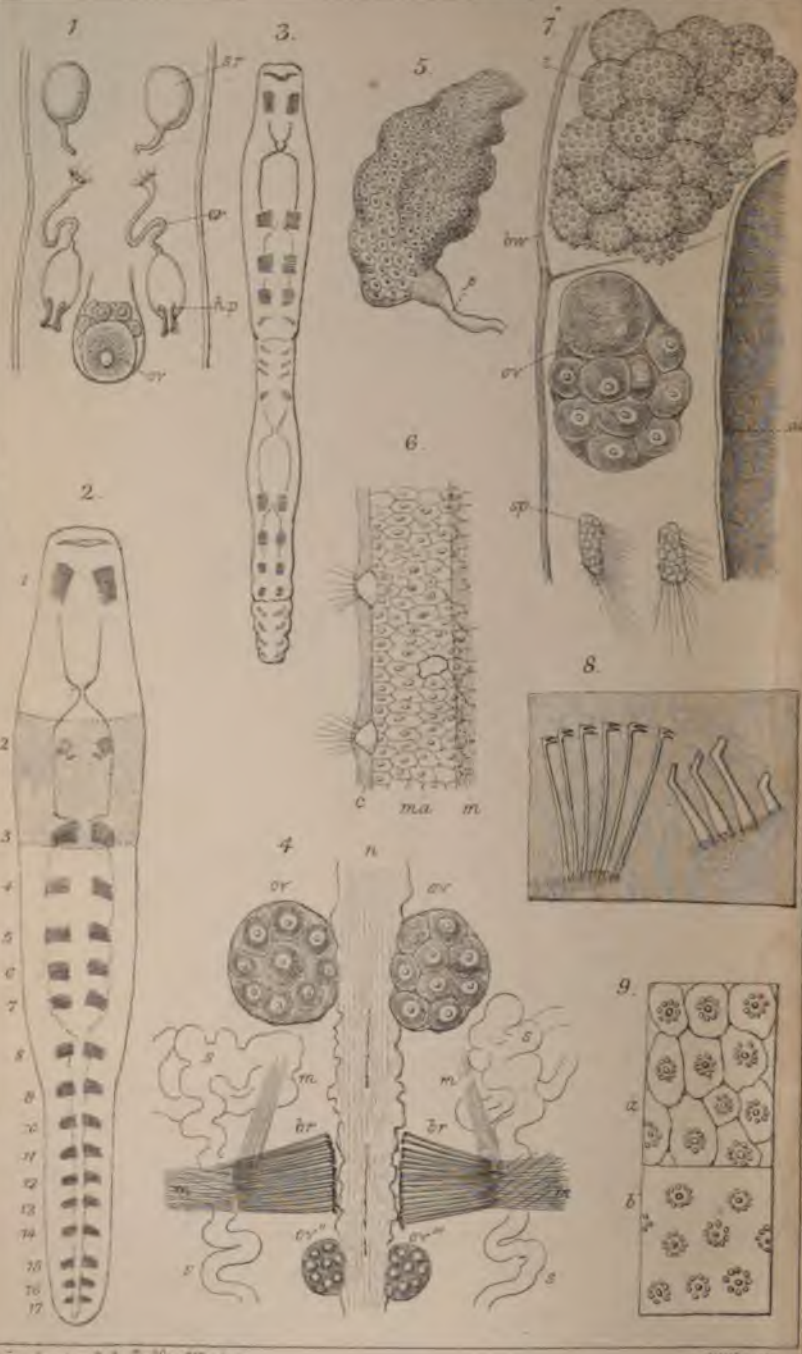
Fig. 1.

he thinnest portion of the auricle of the heart of the hyla, or green tree-frog, showing network of muscular fibres erve fibres; origin of some from a single ganglion cell, and their peripheral ramifications amongst the muscular fibres. The connective tissue corpuscles are represented in the lower part of the drawing to the right only. × 215.

Fig. 2.



A portion of the same specimen as Fig. 1, magnified 700 diameters, showing the relation of the nerve fibres and their nuclei to the muscular tissue.



F.R. Lankester del. Tuffen West sc

W.West imp

DESCRIPTION OF PLATE XIV,

Illustrating E. Ray Lankester's paper on the Sexual Form of *Chætogaster Limnæi*.

Fig.

1.—Reduced copy of M. d'Udekem's figure of the genitalia of *Ch. diaphanus*, from the 'Bulletins' of the Belgian Academy, vol. xii, 1861, p. 243; *sr*, so-called seminal receptacles; *ev*, efferent ducts (entonnoirs vibratiles); *hp*, hard pieces; *ov*, ova.

2.—Sexually mature *Chætogaster Limnæi*, an outline sketch; between 2 and 3 the clitellus is represented.

3.—Larval *Chætogaster Limnæi*, with complete and growing zooids. There is but half the number of bristles in each fasciculus, which is present in the sexual form.

4.—Part of the genitalia of *Ch. Limnæi*: *ov*, the anterior masses of ova; *ov''*, a second posterior pair; *n*, the nerve-cord; *s*, *s*, the most anterior pair of segmental organs; *br*, *br*, the most anterior pair of fasciculi, with sixteen bristles in each; *mm*, the muscles of the fasciculi.

5.—The testis of *Ch. Limnæi* in an early state of development; *p*, its pedicle (?)

6.—Portion of the integument of the sexual form of *Ch. Limnæi* treated with acetic acid; *c*, the cuticle; *ma*, the matrix; *m*, the muscular layer.

7.—From *Ch. Limnæi* in a maturer state than in fig. 4 or fig. 5; *t*, testis; *bw*, body-wall; *al*, alimentary canal; *ov*, ova; *sp*, spermatozoa.

8.—The first fasciculus and *genital setæ* in a sexually mature *Ch. Limnæi*.

9.—Cells of the *clitellus* of *Ch. Limnæi*; *a*, with acetic acid; *b*, untouched.

DESCRIPTION OF PLATE XV,

Illustrating E. Ray Lankester's paper on the Sexual Form of *Chætogaster Limnæi*.

Fig.

1.—Muscle-cells from the septa of adult *Ch. Limnæi*.

2.—Segment-organ of adult *Ch. Limnæi*.

3.—Fasciculus of adult *Ch. Limnæi*, with its bristles turned in two directions.

4.—Ova of *Ch. Limnæi*; *b*, acted on by water.

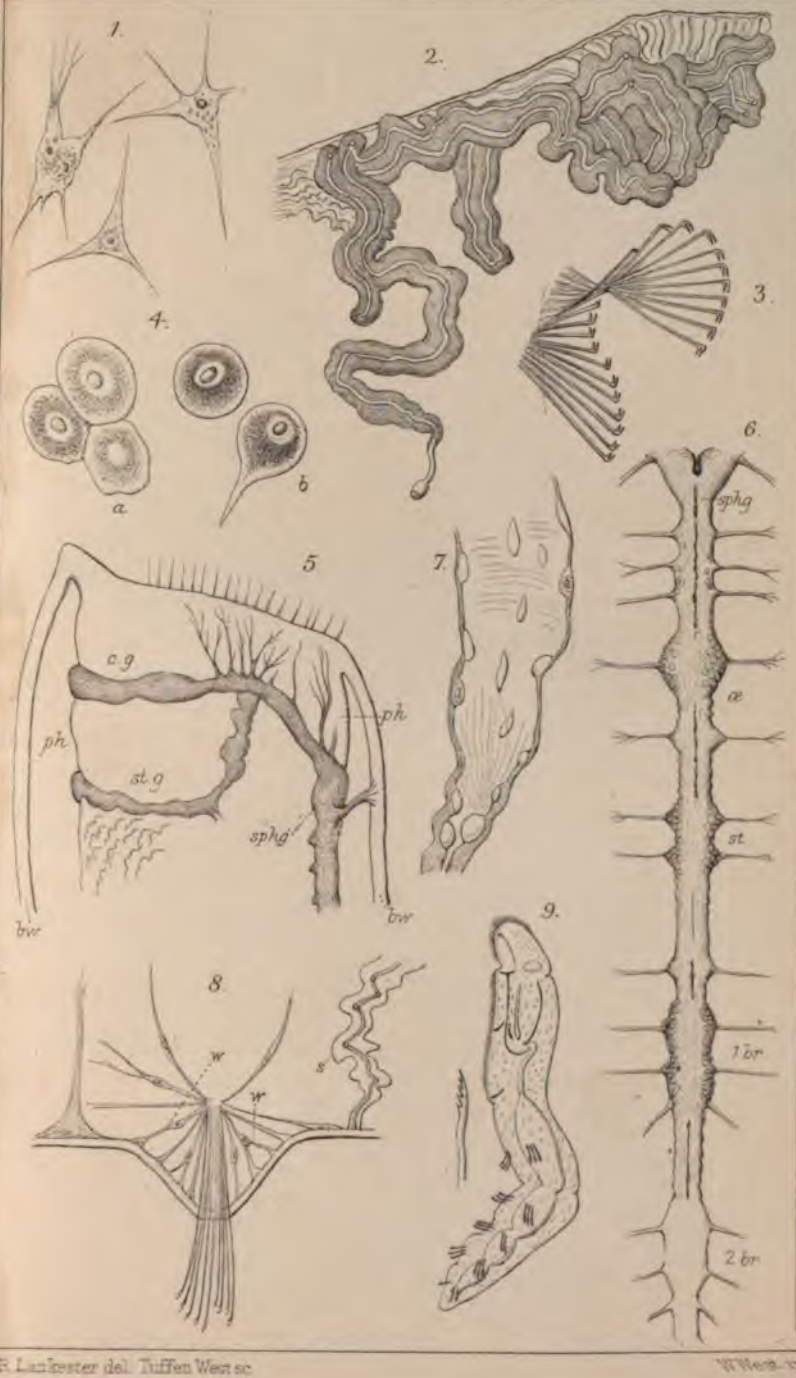
5.—Cephalic region of *Ch. diaphanus*, to show the nervous system; *cg*, cephalic ganglion; *stg*, so-called stomato-gastric or second supra-pharyngeal ganglion; *sphg*, subpharyngeal ganglion; *ph*, pharynx.

6.—Nerve-cord of *Ch. diaphanus*; *sphg*, subpharyngeal; *œ*, œsophageal; *st*, stomachic; 1 *br*, first fascicular; 2 *br*, second fascicular, ganglion.

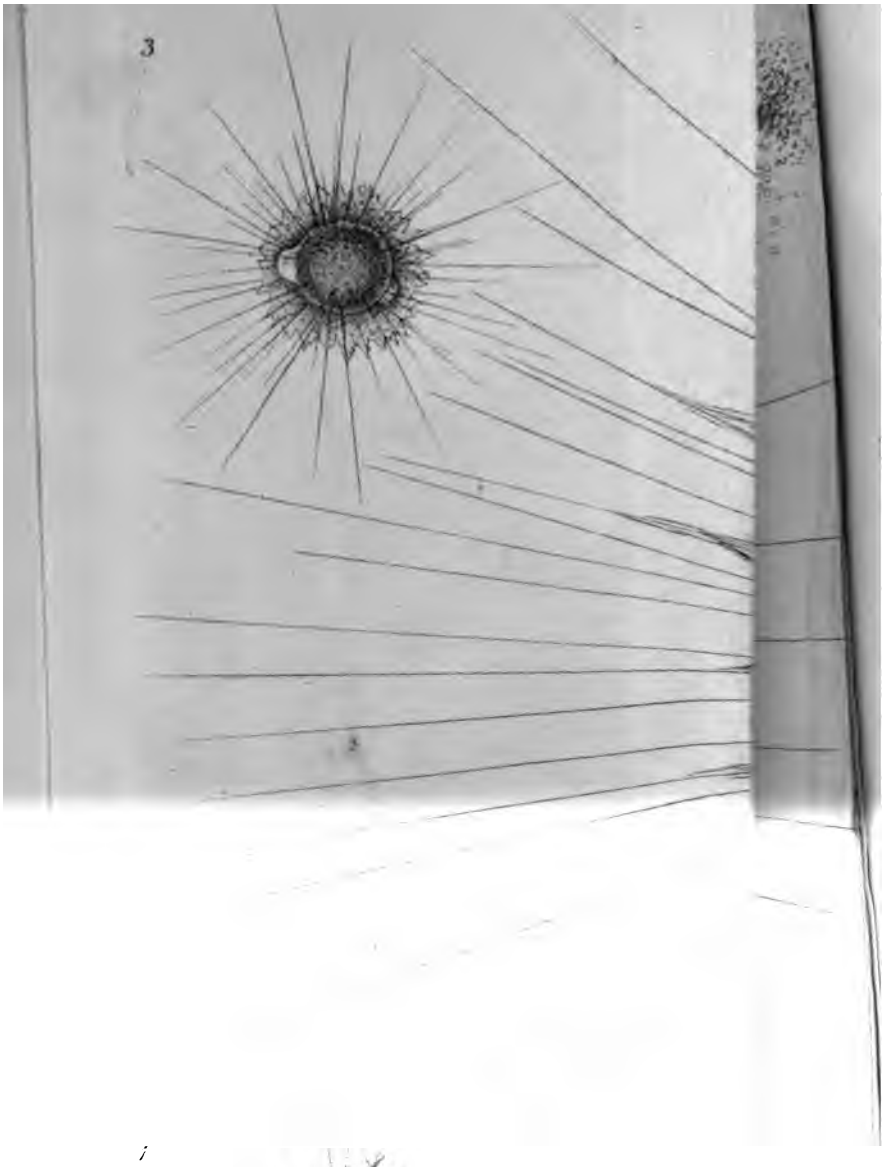
7.—Dorsal vessel of *Ch. Lin næi* (adult).

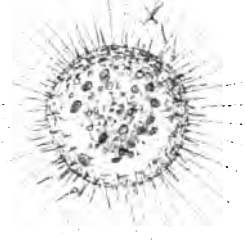
8.—Fascicle and segment-organ (*s*) of *Ch. diaphanus*; *mm*, muscles.

9.—*Parthenope serrata* of Schmidt, *Ctenodrilus pardalis* of Claparède (after Claparède.)


1.
2.
3.
4.
a
b
5
c.g
ph
ph
st.g
sphg
bw
bw
7.
6.
sphg
a
st
1 br
2 br
8.
w
w
s
9.

NEW YORK
LIBRARY





4

DESCRIPTION OF PLATE XVI,

Illustrating Mr. W. Archer's paper on Rhizopoda.

—*Acanthocystis Pertyana* (sp. nov.). A few of the acute radiating spines shown thrown off.

—*Raphidiophrys viridis* (gen. et sp. nov.)

It will be understood, in reference to this figure (as well as the other figures on this and succeeding plate), that the object is drawn as seen when focussed down to the equatorial margin, being brought distinctly to view, and that, of course, the outer investing stratum, here bearing spicules innumerable, is really interposed between the globular central bodies and the observer; but being sufficiently transparent, this intervening stratum allows the central bodies to be seen through it. If it were possible, the pseudopodia should be rendered by a delicate, pellucid, almost silvery line, not by a black one; but this cannot be avoided.

—*Heterophrys Fockii* (gen. et sp. nov.)

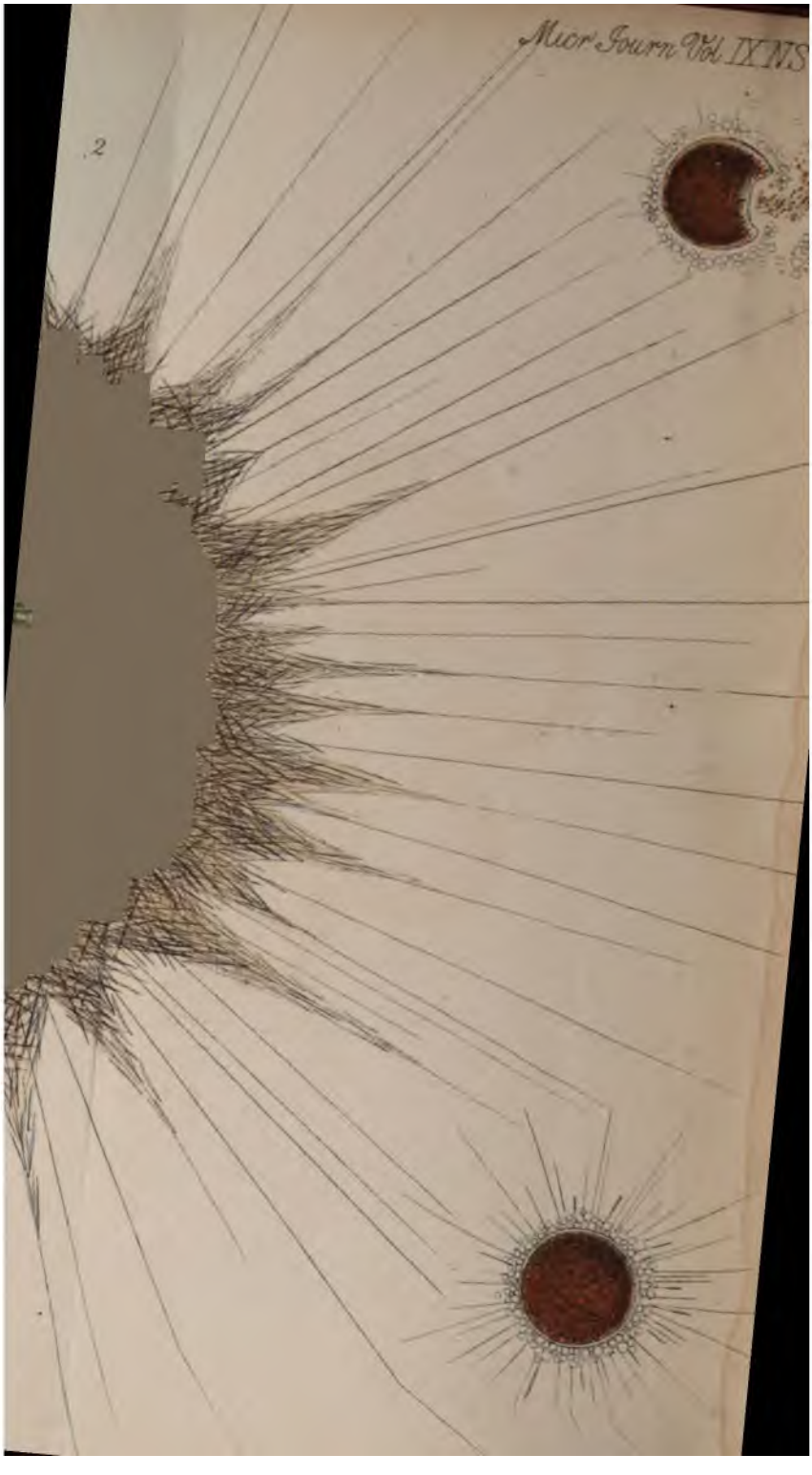
To this figure the same remark applies. The marginal pulsating vacuoles are seen at the highest point of distension. The drawing attempts to indicate the appearance often presented by the "tongue-shaped" processes projected from the margin of the outer stratum; but not unfrequently there is no definite outline, when it becomes difficult to discern where this region terminates.

—*Pompholyxophrys punicea* (gen. et sp. nov.)

The outer vesicles, of course, cover the whole of the external surface of the reddish body, though seen only at the margin, being, as before, focussed down. The body contains a minute captured Cymbella. The figure hardly represents the reddish granules sufficiently individualised; the contents are not so homogeneous-looking.

—The same, submitted to pressure, some of the pigment-granules crushed out, and some of the outer vesicles scattered.

All the figures × 400.



DESCRIPTION OF PLATE XVI,

Illustrating Mr. W. Archer's paper on Rhizopoda.

Fig.

1.—*Acanthocystis Pertyana* (sp. nov.). A few of the acute radiating spines shown thrown off.

2.—*Raphidiophrys viridis* (gen. et sp. nov.)

It will be understood, in reference to this figure (as well as the other figures on this and succeeding plate), that the object is drawn as seen when focussed down to the equatorial margin, being brought distinctly to view, and that, of course, the outer investing stratum, here bearing spicules innumerable, is really interposed between the globular central bodies and the observer; but being sufficiently transparent, this intervening stratum allows the central bodies to be seen through it. If it were possible, the pseudopodia should be rendered by a delicate, pellucid, almost silvery line, not by a black one; but this cannot be avoided.

3.—*Heterophrys Fockii* (gen. et sp. nov.)

To this figure the same remark applies. The marginal pulsating vacuoles are seen at the highest point of distension. The drawing attempts to indicate the appearance often presented by the "tongue-shaped" processes projected from the margin of the outer stratum; but not unfrequently there is no definite outline, when it becomes difficult to discern where this region terminates.

4.—*Pompholyxophrys punicea* (gen. et sp. nov.)

The outer vesicles, of course, cover the whole of the external surface of the reddish body, though seen only at the margin, being, as before, focussed down. The body contains a minute captured Cymbella. The figure hardly represents the reddish granules sufficiently individualised; the contents are not so homogeneous-looking.

5.—The same, submitted to pressure, some of the pigment-granules crushed out, and some of the outer vesicles scattered.

All the figures × 400.

DESCRIPTION OF PLATE XVII,

Illustrating Mr. W. Archer's paper on Rhizopoda.

Fig.

1.—*Cystophrys Haecheliana* (gen. et sp. nov.), seen in its ordinary condition, the pseudopodia fully and equally extended; the cells showing their light-coloured nucleus and nucleolus, and, occasionally, the bluish granular contents showing a somewhat large, reddish one; one of the cells showing self-fission.

2.—The same, endeavouring (and finally succeeding) to encompass a fibre of wool, some of the internal cells seemingly getting thrown off in the effort, the delicate sarcode layer becoming stretched along and round the extremity of the wool. One or two of the cells show self-fission.

3.—*Cystophrys oculea* (sp. nov.).

The outline of the reddish nuclear bodies is hardly sufficiently strongly indicated by a sharp dark line, nor is the inner nucleolar black dot sufficiently pronounced. It is difficult to execute these details, even on a scale of 400 diameters. In some of the inner cells will be seen double nuclei, presumably indicating progressing self-fission. If it were possible to render the very slender pseudopodia by colourless silvery lines, it would be more true to nature, but the figure will, it is hoped, enable observers to identify this form.

4.—*Heterophrys myriopoda* (gen. et sp. nov.).

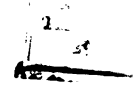
In this figure, by some accident, the marginal region or border has been drawn at the left-hand side of greater depth than at the remaining three fourths of the circuit; it ought to be pretty equidistant all round. The remark made as to its being focussed down to the extreme margin here holds especially good; it will be of course understood the outer region intervenes between the central chlorophyll-bearing otherwise rather hyaline body and the observer.

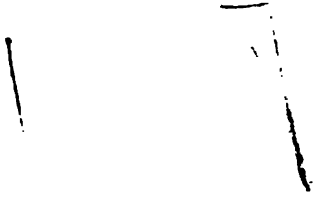
5.—*Clathrulina elegans* (Cienkowski).

It is hard to convey the transparent character of the perforate skeleton of this pretty creature, combined with the light brownish colour proper to fully developed specimens. The pseudopodia are rendered somewhat too thick and pronounced; they are very delicate and colourless.

All the figures × 400.

del. Tuffen West sc.





1a

6.

1d

7.

1c

8.

3.

9.

1b

5.

4.

2a

2b

DESCRIPTION OF PLATE XVIII,

Illustrating Dr. Donkin's paper on certain Species of Fresh-water Diatomaceæ.

Fig.

1.—*Surirella Barrowcliffia*, Donkin. *a*, S. V. *b*, M. V. *c*, Frustule dividing. *d*, Oblique view of frustule.

2.— „ *subalpina*, Donkin. *a*, S. V. *b*, Oblique view of valve.

3.— „ *tenera*, Greg. S. V.

4.—*Navicula Coquedensis*, Donkin. S. V.

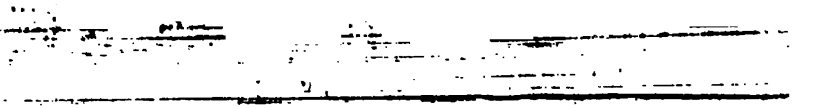
5.— „ *vernalis*, Donkin. S. V.

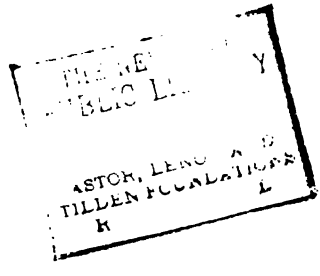
6.— „ *Cymbula*, Donkin. S. V.

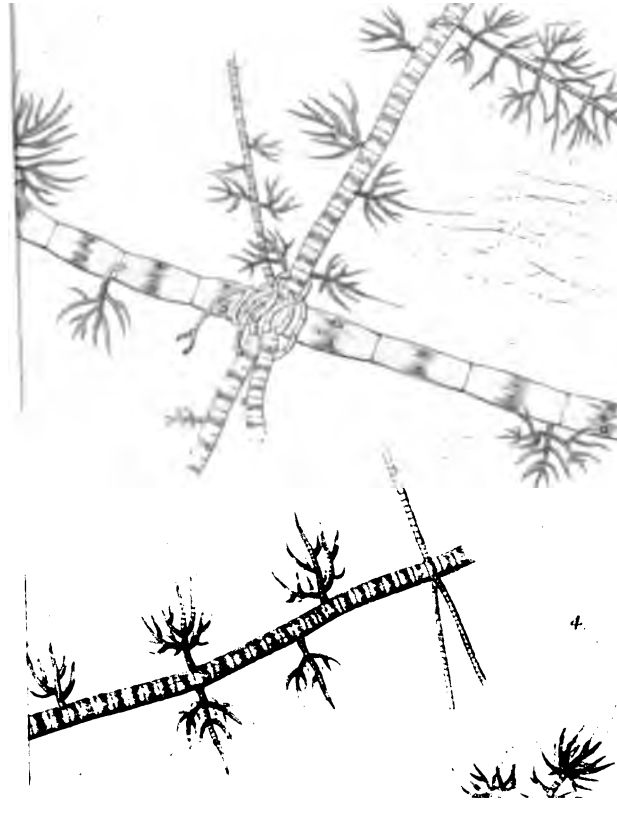
7.— „ *limosa*, Ktz. S. V.

8.— „ *firma*, Ktz. S. V.

9.— „ *stauroptera*, Ehr. S. V.







DESCRIPTION OF PLATE XIX,

Illustrating Dr. J. Braxton Hicks' paper on *Draparnaldia cruciata*, Hicks.

Fig.

1.—Portion of plant magnified about 4 times.

2.—Main filament with lateral tufts.

3.—Secondary filament.

4.—End of secondary filament.

5.—Disposition of endochrome, from a cell $\frac{1}{600}$th inch in diameter.

6.—Radicles.

7.—Formation of zoospores.

DESCRIPTION OF PLATE XX,

Illustrating Mr. W. Archer's paper on Rhizopoda.

Fig.

1.—*Pleurophrys? spherica*, Clap. et Lachm.? In the centre of the body-mass, which is not in contact with the curious test, which is formed of indistinguishable short bacillar and rounded particles agglutinated together, is seen a large orbicular "nucleus." From the anterior extremity is given off a considerable tuft of slender, linear, slightly branched pseudopodia.

2.—*Pleurophrys? amphitremoides* (sp. nov.). The specimen figured is covered with numerous adherent navicular and other Diatomaceous frustules and arenaceous particles, and the body somewhat densely loaded with chlorophyll granules, the anterior extremity giving off a rather dense tuft of slender branched pseudopodia.

3.—*Pleurophrys? fulva* (sp. nov.). Shows the buff or tawny colour of this minute form; the test covered by angular, pellucid, quartzose particles; the anterior extremity giving off a short, rather dense, and branched tuft or shrub-like cluster of pseudopodia.

4.—*Amphitrema Wrightianum* (gen. et sp. nov.), from a specimen taken from "Feather-bed Bog," near Dublin; shows the mass of the body coloured green by chlorophyll-granules. The drawing has been made from a selected example in which each of the very short necks of the test is more than ordinarily evident, owing to the paucity of the external adherent foreign particles at those points, which, when present, tend to obscure it. These particles are to be seen most crowded along the lateral margins of the compressed elliptic test, leaving the central region more or less free from them, and thus allowing the sarcode-body within the more readily to be seen; each extremity giving off a more or less dense tuft of branched pseudopodia, that from one of the extremities being, however, almost always more elongate and crowded than the other.

5.—The same species, from a "Glen-ma-lur" specimen, likewise selected the better to exhibit the two short necks appertaining to this form, owing to their exceptional freedom there from foreign particles. These latter, as in the preceding example, are here also seen more plentiful towards the lateral margin, but they are in this specimen somewhat less coarse; the test itself, too, is slightly larger; like the previous example, the tuft of pseudopodia from one extremity is larger, longer, and more crowded than from the other.

6.—*Diaphoropodon mobile* (gen. et sp. nov.), showing the anterior, much branched, and tufted pseudopodia extended, but not as fully so as in some of the examples witnessed. To the right is the anterior marginal pulsating vacuole fully distended; to the left, immersed in the body-substance, is seen the large spherical "nucleus," the outer margin bordered by the fringe-like processes.

7.—*Gromia socialis* (sp. nov.). Showing a group of three mutually united by anastomosis of their more or less reticulately branched pseudopodia, which here and there present variously shaped expansions, bearing different sized rather opaque granules, carried about in slow circulation. Immersed in the body portion of each is seen the whitish nucleus with its darker central nucleolus.

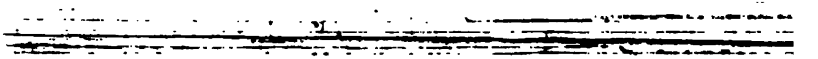
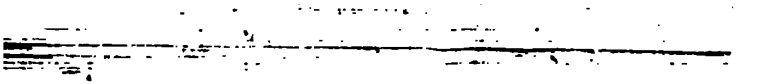
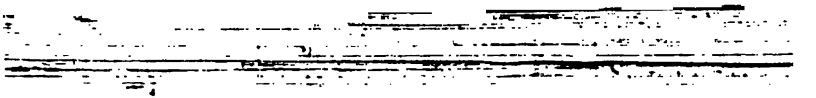
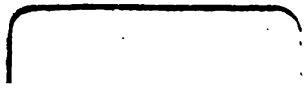
8.—The same; a single individual, showing a very long and branched pseudopodium.

9.—The same; a single stemlike sarcode prolongation projected, branching at the top in a ramified dendroid manner; this being rather exceptional.

10.—The same; an example showing a pseudopodium expanded into a clavate form, and enclosing some of the larger semi-opaque granules, like those in the intervening spaces of the conjoined pseudopodia of the three associated examples shown in Fig. 7.

11.—The same; showing an example in which the body has undergone a transverse self-fission, and in each portion a nucleus with its nucleolus is present, the upper segment giving off branched pseudopodia in the usual manner.

12.—*Difflugia carinata* (sp. nov.), × 200.

All the figures × 400, except fig. 12, × 200.

J. Archer del.
W. West imp.